MACHINE DESIGN

PARTS • MATERIALS • METHODS • FINISHES

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Itemized Index

CLASSIFIED FOR CONVENIENCE WHEN STUDYING SPECIFIC DESIGN PROBLEMS

Key: Edit., Editorial Pages; Adv., Advertising Pages; R, Right hand column; L, Left hand column


RESEARCH
With this new ultra-high power metalloscope metallurgists in our laboratories are constantly making new explorations in steel, rolling back the frontiers of metallurgical knowledge. By magnifying etched steel samples 10,000 times, they get "closer" to the steel than ever before. They see new things, discover new clues—clues like those which led to the better steels pictured.
LEFT: In turning out a higher grade product in the foundry — or
producing ingots for tool steels, forging steels and special alloy steels
cluding stainless steels, the 3-phase Heroult Electric Furnace buil
the American Bridge Company has amply demonstrated its special
vantages. In the last 25 years, many advances that have been ma
both the production and use of ferrous materials would have bee
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BELOW: Gleaming USS Stainless Steel made possible this b
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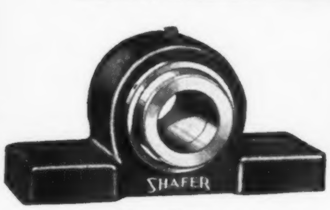
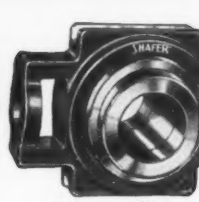


Pillow Block

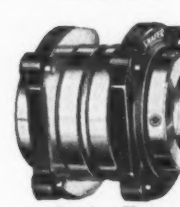
Flange Unit



Take-up Unit

Hanger Box

Cartridge Unit



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Topics . . .

SELECTIVE surface hardening of steel by electrical induction has progressed to the point where it becomes a practical process which can be specified by the designer. Since electricity can be controlled accurately, the process is said to permit the surface heating and quenching of practically all ferrous materials of cylindrical section, with the resulting hardened surface kept within close limits as to area and depth. The first application to be worked out and perfected for industrial use has been the hardening of crankshafts at the bearing surfaces. Crankshafts to be hardened by the process are made from steel which in addition to passing the usual mill inspection tests is preferably of the fine-grained type.

♦ ♦ ♦

Another maturing development in the use of materials for design is the advance made in the casting of rubber. This versatile technique, according to the *Industrial Bulletin*, produces vulcanized rubber or equivalent rubber-like material with almost any desired set of properties, including the utmost in tensile strength (over 5000 pounds per square inch), great elasticity, and ability to withstand light, heat, ozone, oil and what not. If there are limitations in the material, it is that high-grade goods are far easier to produce than are low-grade. The process is particularly applicable to the production of molded articles which either cannot be made at all by former technique or which called for the use of highly expensive pressure vulcanizing molds. Thus a new field is opened to designers.

♦ ♦ ♦

Materials such as these make many designs possible. An example of just such a development is found in a new type of machine for making mayonnaise. This machine churns the liquid mixture between a stator and a rotor revolving at a very high speed The mill shaft journals are all being covered by a welded-on layer of a special cobalt-base alloy to prevent wear and the chemical attack of vinegar seeping through the packing.

♦ ♦ ♦

Composite materials have lengthened the life and increased the reliability of tubing used for severe service such as that experienced in this mayonnaise machine. This tubing is used where it is desired to combine the strength of steel with the corrosion-resistant properties of nonferrous metals or stainless steels. To create the tubing, two or more tubes of different metals are drawn together through a die, over a mandrel, effecting an extremely strong, close-adhering bond.

♦ ♦ ♦

One of the most interesting design developments is the practical solar heat engine demonstrated by Dr. Charles G. Abbot at the Third World Power Conference. With this machine Dr. Abbot can focus the sun's rays to the width of a lead pencil on a liquid-filled tube by concave aluminum mirrors. The engine reflects over 80 per cent of the solar rays. The present model drives a one-half horsepower motor coupled to a small dynamo.

♦ ♦ ♦

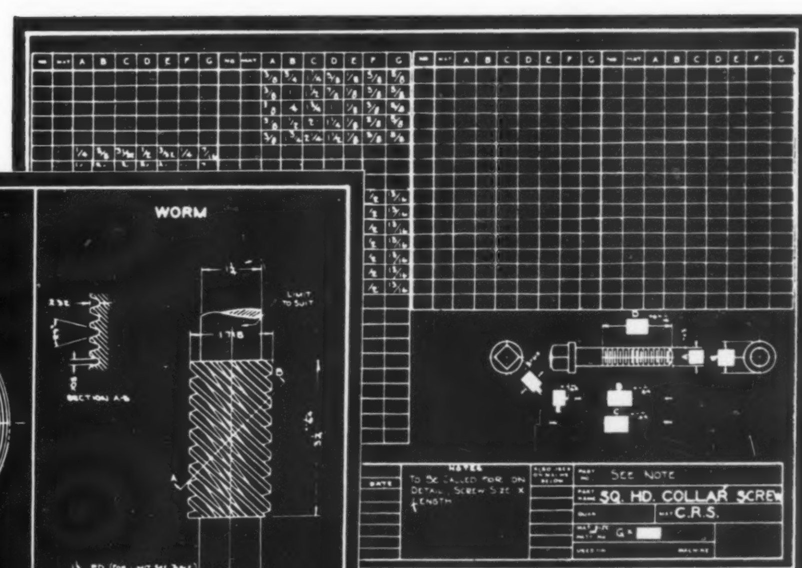
Machines such as this solar engine may be considered to be mere experimental fantasies, but one must never forget that it is these first experimental models that result in practical machines. For example, the electric eye, long applied to scores of operations experimentally, is now a working member of the machine parts union. The latest machine to be announced on a commercial basis as incorporating this part is an automatic traffic recorder which utilizes invisible infra-red rays and an electric eye to count and record the number of vehicles passing over a road every hour. It is intended for use by motor vehicle departments and similar organizations in analyzing traffic flow.

(*Concluded on Page* 108)

MACHINE DESIGN

Has Your Organization a Standards Book?

By Guy Hubbard



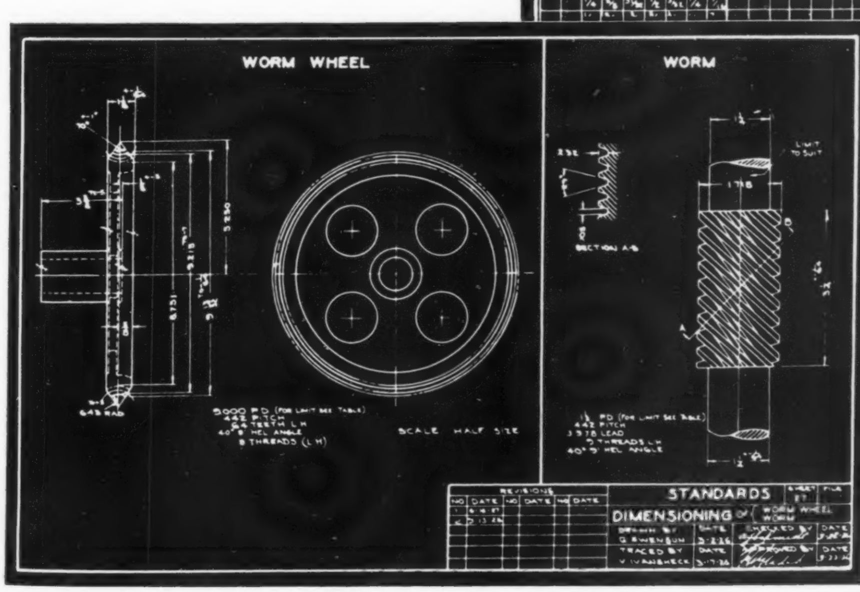


Fig. 1—Left—Approved dimensioning of worm wheel and worm

Fig. 2—Above—Master sheet covering standard collar screws

NEARLY eighty years ago John Nystrom, pioneer in the compilation of mechanical engineering handbooks, made the statement that it is up to every engineer to "build his own handbook" over the entire period of his active career. That can well be applied to the building up of standards and standards of procedure in the engineering department.

The trouble usually is that the rules "just grow" and by the time their cultivation is under-

taken they have grown to such a degree that it is difficult if not impossible to correct their basic deficiencies. For example, the standard gage for railways came from that of horsedrawn vehicles. By the time forward-looking engineers questioned it, the country had been covered with a network of rails laid to that standard, thousands of locomotives and cars had been built to it, and so—for better or for worse—it still is with us.

One lesson that might well be drawn from this is that when a new engineering department is organized, or an old one is revamped, the time to choose basic standards is *immediately*. That includes the thoughtful adoption of standard sizes of drawings, systems of records, methods of filing, systems of numbers for parts, patterns, jigs, fixtures, etc., lists of standard bolts, nuts, washers, pins, cam rolls, and many other fundamental things familiar to every engineer who ever has had to do with designing machinery for production.

Modify the System to Fit the Needs

While it is well to draw heavily upon the experience of other and older companies, it is equally important that originality be used in conforming systems to the special needs that every company has. In other words, build on a foundation of experience but do not be too ready to erect a ready-made structure thereon.

In older companies, particularly those which have been manufacturing the same or similar products for many years, the overhauling of standards and procedure in the engineering department calls for courage and persistence. High expectations should not be held that anything revolutionary can be accomplished overnight, unless by chance a lot of "die-hards" among personnel and products pass out of the picture suddenly. Models do change much more rapidly these days than formerly and general adoption of basic standards is more common than it was a few years ago. Consequently, more opportunities are arising when long, quick strides can be taken. At least a beginning can be made if it be nothing more than a screw list. It is amazing what a needlessly large number of sizes and kinds of screws are carried in stock in plants where every draftsman has been allowed to specify them without regard to what already is available.

It is not the purpose of this article to enter into a discussion of engineering department standards and procedure as such, but rather to glance briefly at some of the things that have been done by large and successful companies toward putting their standards on record to make them available throughout the organization. This is being done most effectively, judging from several excellent examples, by means of loose-leaf books which can change with the system. These standards books not only are useful in guiding the older members of the engineering department but they also are extremely helpful in quickly "breaking in" draftsmen, designers and engineers who are new in the organization. The last is of great importance in these days when engineering departments are expanding rapidly from skeleton organizations to full quota.

All of the books are loose-leaf, most of them having 8½ by 11-inch sheets. In every case they are dynamic rather than static, in other words they are designed to help with the latest data rather than to hinder with outgrown rules.

Most of the material is mimeographed or reproduced by the offset process, the latter enabling clear reproduction of drawings regardless of original size. In a few cases the introduction is printed, when this is applicable generally to the entire office force of a large organization. The most convenient books are those which are divided into sections with tabbed index sheets between them.

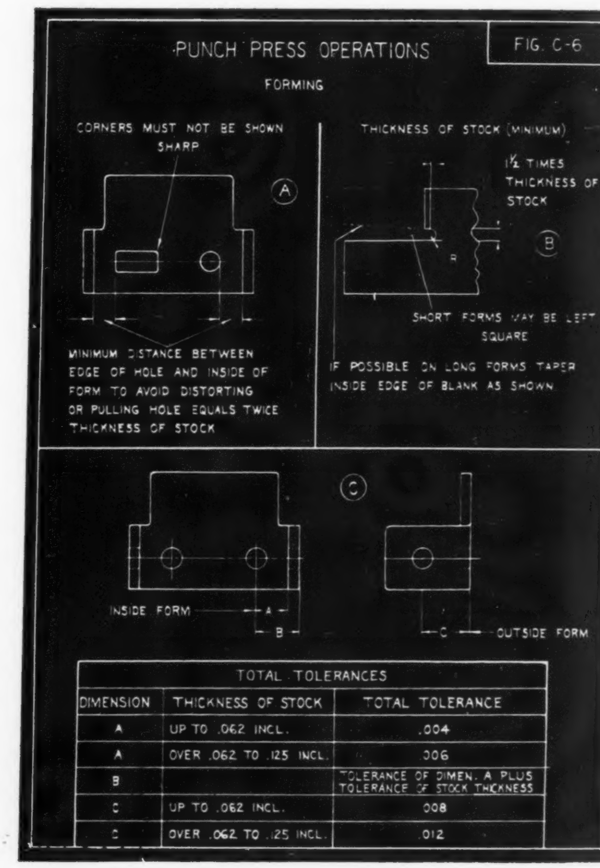


Fig. 3—Basic facts are given on shop practice so that "working drawings" may be worthy of the name

To give an idea of the scope of one of these books, here are titles of its sections: General Index; Sec. A, Foreword; Sec. B, Elementary Drafting Room Instructions; Sec. C, Detail Design—Shop Practices; Sec. D, Assemblies—Layouts; Sec. E, Metal Finishing—Plating; Sec. F,

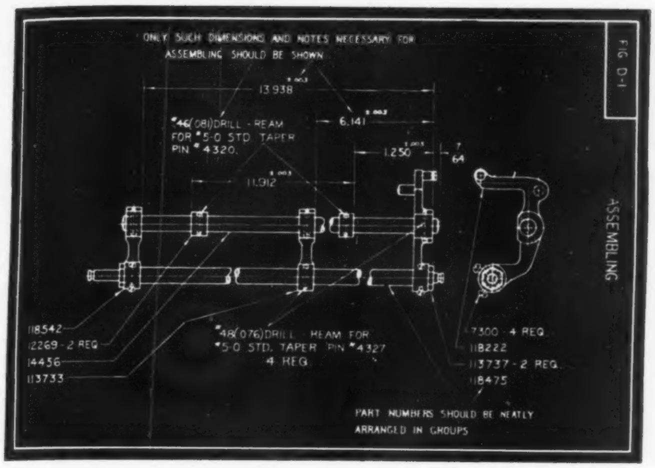


Fig. 4—Sample assembly drawing giving only that information which is essential to proper assembly

Heat Treatment; Sec. G, Selection of Materials; Sec. H, Insulating Materials—Electrical Data; Sec. J, Engineering and Records Procedure; Sec. K, Tables.

Sec. B covers: Drawing Sizes; Types of Lines; Lettering; Sectioning; Dimensioning; Scale; Views; Notes and Title; Revisions to Drawings; and Care of Drawings.

Sec. C, which is unusually complete, covers: Detailing; Standard Parts; Purchased Parts; Tolerances— General; Drill Press Operations; Screw Machine Operations; Milling Machine Operations; Gears; Extension and Compression Springs; Tolerances on Fractional Dimensions; and Die Castings.

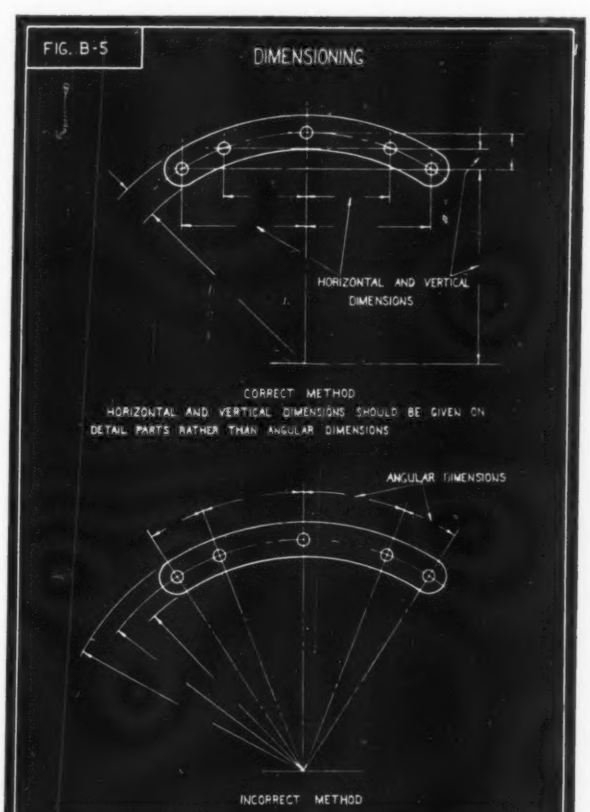


Fig. 5—Correct method of dimensioning insures quick, accurate interpreation by workmen in the shop

Being engaged in a mass production of a wide and complicated line of machinery, the company using this book has a large research and development department. This department has contributed and constantly is contributing vital material to the standards book, all of which puts rule-of-thumb engineering very definitely out of the picture.

The purpose of this book, or in fact of any comparable one, is summed up in a quotation from its introduction:

"The intent is to effect uniform methods in the treatment of problems common to all departments, including the model shop and the factory production departments. Strict observance of this Book of Standards will help to avoid—in designs and specifications—any features that may cause manufacturing difficulties, increase the cost of manufacture and result in field service difficulties."

It is significant that there is specific information in these standards books in regard to basic shop operations about which the average draftsman used to know little and care less. Without admitting unfamiliarity with shop practice, he often would put through drawings which lacked completeness. He did this on the assumption that the mechanics would quietly draw on their own experience to fill in deficiencies in the graphical instructions.

When it is observed that modern standards books go into detail on a subject such as proper dimensioning for the press-forming of metal, it is apparent that "working drawings" are now supposed to be all that the name implies. Not only are they expected to "tell the whole story" but also to tell it correctly.

Automobile Industry Sets Fine Example

Standards books are playing an unusually important part in the automobile industry. It is not much to say that the mechanical reliability of the modern automobile is to no small degree due to the fact that engineering departments in this industry are guided by standards books which are more than ordinarily complete and up-to-date. These books, which get constant attention from high engineering authorities, go into detail on subjects such as physical properties of alloy steels, thickness of electro-plating for various services and allowable torque when setting down nuts.

Illustrations in this article are from sheets selected from standards books in active use. In this connection a word of appreciation is due especially to American Machine & Foundry Co., Chrysler Corp., the Hoover Co., International Business Machines Corp. and Pitney-Bowes Postage Meter Co. for their co-operation.

SCANNING THE FIELD FOR IDEAS

WHEN operating mills and mixers of the revolving horizontal drum type, it is important that they can be brought to a stop quickly and accurately with the loading port at the top and the discharge port at the bottom. To eliminate ratchets and other purely mechanical means for accomplishing this, Patterson Foundry & Machine Co. has developed a system of combined electrical drive and control of which a general view is shown in *Fig.* 1.

This system consists of a high torque motor and speed reducer built as an integral unit and mounted on a heavy cast iron base which requires no special foundation. The slow speed output shaft and bearing of the reducer are of sufficient strength to permit of the mounting of the mill drive pinion directly upon this shaft, the gears being fully guarded. The free end of the motor shaft is extended and carries a fully enclosed magnetic brake.

Control is by means of a three-station push-button with "Start," "Stop" and "Inching" buttons. The magnetically operated brake is connected into the circuit so that in either the "Stop" or "Inching" position the rotor is gripped tightly and prevented from turning in either direction. When the "Start" button is pushed the brake releases before the current reaches the motor windings, the same being true when the "Inching" button is pushed. The "inching" mechanism will operate as long as its button is held down, consequently it is possible thus to operate the motor for only a fraction of a second or for a period of say five or ten seconds. When this button is released, the brake immediately grips, preventing further movement of the rotor in either direction.

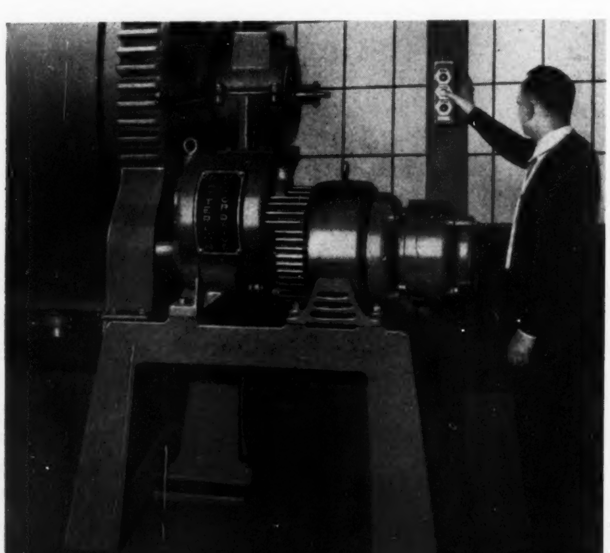


Fig. 1—This electrical mill drive embodies a magnetic brake and "inching" device, giving exact control

HYDRAULIC JACK IS DIE CAST

IN THE early days of the die casting industry, mechanical strength of the castings was a very uncertain factor. Consequently they were not used to any extent in places where strength was important. Through the use of scientifically mixed alloys and through improved methods of casting, all this has been changed. As a result, die castings are being specified today in places where strength and uniform quality are of very great importance.

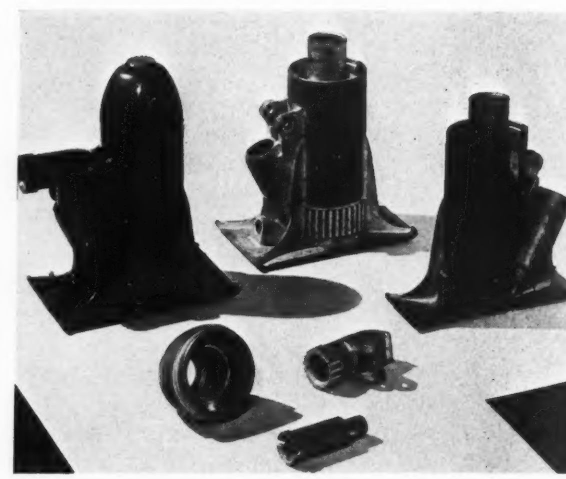


Fig. 2—This hydraulic jack depends upon the castings for strength, simplicity and good appearance

A good example is the Blackhawk hydraulic automobile jack die cast by Stewart, shown in *Fig.* 2. There are three highly significant de-

sign points in this device. First, is the strength of this zinc alloy die casting assembly. Hydraulic tests on die cast cylinders similar to the pressure chamber of this jack indicate that sixty tons pressure is necessary to burst them. Second, is the intricate system of coring which has been successfully worked out in connection with the main casting in which are embodied cylinder, reservoir and pump chamber. This coring is depicted by the sectioned casting at the right side of the cut. Third, is the manner in which a purely utilitarian group of elements —a cylinder, a reservoir and a pump—have been combined into a compact, neatly styled assembly made up of minimum number of parts.

CONVEYOR BECOMES SELF-CONVEYING

WHILE chain conveyors of the so-called flight type are fast and efficient movers of material such as coal and gravel, it often happens that they require considerable attention in the way of moving them about and keeping them fed with material. To overcome this, George Hauss Mfg. Co. has developed a system whereby either gasoline or electric power not only is applied to the running of the chain but also for quickly moving the conveyor to the pile and making it dig its own material therefrom. This system makes it self-feeding and also serves to distribute the material evenly in the truck as it flows from the delivery end. The machine can be handled by a single operator.

The digging end of an electrically driven flight conveyor of this type is shown in action in *Fig.* 3. The motor is mounted in a casing on the self-propelling chassis, with its pinion meshing with a gear on an intermediate shaft which in turn is geared to a shaft carrying the two wheel driving pinions. These pinions are driven through jaw clutches. Steering is accomplished by engaging one or the other of these

Fig 3—Through power drive to wheels this conveyor moves itself from pile to pile and is self-feeding

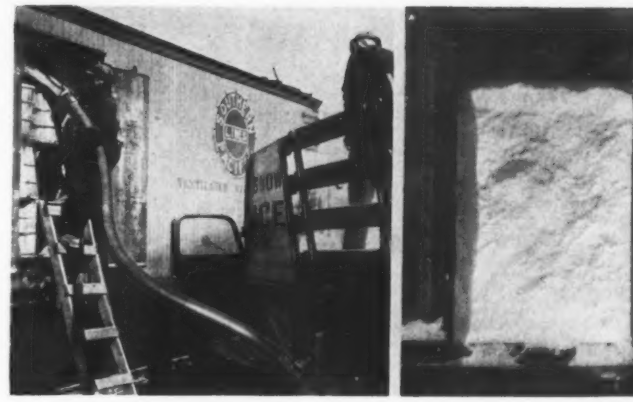


Fig. 4—Machine which pulverizes ice and slings resulting "snow-ice" through a hose, affords new method for car refrigeration

clutches as required and straight travel by engaging both. Reversal of the electrically driven machine is by means of a reversing switch, while in the gasoline model a double system of pinions and clutches is provided.

SNOW BLANKET IS MADE FROM ICE

TOP-ICING of refrigerator cars of green vegetables by the use of "snow" made from blocks of ice is said to provide necessary refrigeration and moisture to enable even transcontinental shipments without re-icing. The application and final result of this system of icing is shown in the combination cut, *Fig.* 4.

At the left of the cut a Link-Belt ice crusher and centrifugal slinger can be seen suspended below the floor of a truck. One operator is lowering a block of ice into the crushing unit while the other directs the high speed blast of snow-ice from the rubber discharge pipe over the material in the car. As this goes on, the blast also serves thoroughly to precool the car, and the packing effect of the snow-ice firmly locks the cargo in place thereby preventing damage incidental to subsequent rough handling.

AUTOMATIC MACHINE FEEDS ITSELF

AN EXAMPLE of a built-in materials handling mechanism is given by the automatic magazine feed shown in *Fig.* 5.

This is depicted in connection with a small high speed automatic lathe built by Seneca Falls Machine Co. Parts being handled in this case are bronze bushings which already have been bored. These can be seen in the chute at the top, this being kept filled by the operator. From the bottom of this chute the bushings are pushed one by one toward the left by a loader which presses them firmly onto the arbor held in the spindle nose.

Following passage of the turning tool over

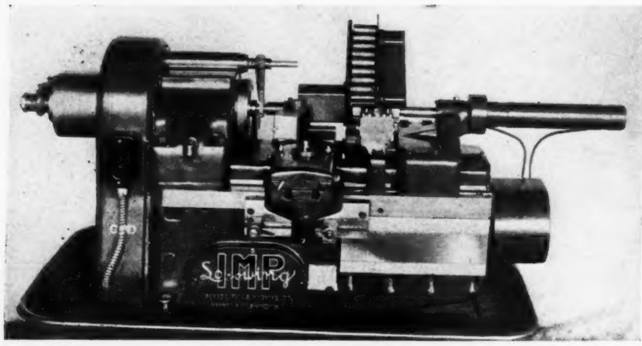


Fig. 5—Magazine feed with automatic loading and unloading mechanism cuts nonproductive time to minimum

the work—and as it withdraws—a stripper pushes the finished bushing off the arbor and into a discharge chute. Both machine and loader operate very rapidly on a continuous integrated cycle which reduces idle or nonproductive time to the minimum.

ABRASION ARMOR PROTECTS VIBRATOR

VIBRATION is applied industrially in many ways, often to speed up an action which under natural conditions is very slow—as for instance the "aging" of an iron casting. This effect now is being used in the puddling of concrete, which is found to prevent honeycombing by eliminating air bubbles in the mass.

In *Fig.* 6 is shown one of these portable gasoline-driven mechanical vibrators developed by White Mfg. Co. Similar machines with electric drive also are available. The mechanical system consists of a sturdy flexible shaft connected to the power source through a twin-disc clutch and speed increasing chain drive. At the outer end of the shaft is the torpedo-shaped vibrator shell, within which is an eccentric rotor. The "wabble" of this rotor gives vibrations of 3800 to 4200 per minute at comparatively low engine speeds.

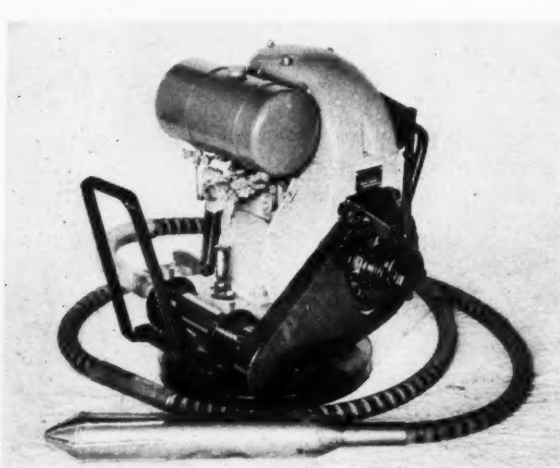


Fig. 6—Mechanical vibration of abrasion resisting nosepiece speeds up puddling of concrete

An interesting feature from the design point of view is the casing of the vibrator head which is subject not only to vibration but also to abrasion by the concrete mix. To give it long life under these conditions, it is made of alloy steel with abrasion-resisting ribs on the nose. These ribs, which are deposited by the arc welding process, can be seen plainly in the cut.

DRINK MIXER SHAKES THEM UP

ELECTRIC drink mixers operating on the "egg beater" principle, long have been recognized labor saving machines. Now comes one which duplicates the hand action of combined shaking and rolling a capped glass.

A mixer, or—more properly—a shaker, of this type developed by Walter Watling Inc. is depicted in *Fig.* 7, set up and ready for action. While it is light enough to be moved around readily, it is prevented from "creeping" by four suction cups which also serve as "floating power" cushions.

Fig. 7—Combined up-and-down and rolling motions effected when shaking drinks by hand are reproduced mechanically by this electrically driven shaking mixer

After putting the ingredients into the graduated glass and capping it with the chromium plated cup, the two are automatically gripped on the rocker arm when it is tilted back into operating position. This arm has an endwise shaking motion and at the same time a rolling motion, the combination giving quick, thorough mixing. Controls consist of a time switch on the front of the case, giving automatic stopping at any point between thirty seconds and three minutes, and a rheostat knob at the side by which the speed of shaking can be set to suit the drink. Action is started by pressing a lever on the side of the case. Motor, driving mechanism and controls are housed within the styled enamel base.

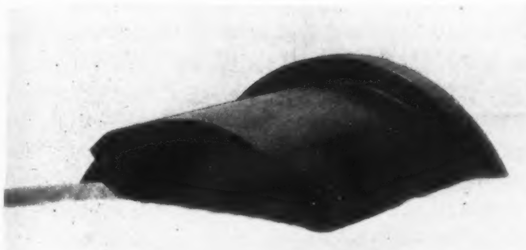


Fig. 10—Keys molded on the back of the bearing fit into suitable milled grooves

Part II

Phenolic Plastics—

Design's Latest Bearing Material

By O. K. Graef

DESIGNERS sometimes make the error of utilizing an entirely unsuitable bearing because of failure to foresee the probable methods of use and operation of the machine. For instance, a certain dairy machine was equipped with antifriction bearings in suitable closures. While the closures sealed the lubricant in the bearing perfectly during operation, it was necessary to wash the machine down with steam and water frequently and often the hose was turned upon the bearings. Inevitably some of the water found its way into the bearings and their life was short. Plastic resin bearings such as those discussed in the first section of this article on page 34 of the September issue of MACHINE DESIGN, were substituted and no further trouble was experienced. This successful application led the operator to replace the ball bearings on another machine. Here the conditions were entirely different; water never came in contact with the bearings and their location made them almost inaccessible because of the almost constant operation of the machine. The plastic bearings failed shortly through lack of lubricant, and the more suitable ball bearings were replaced.

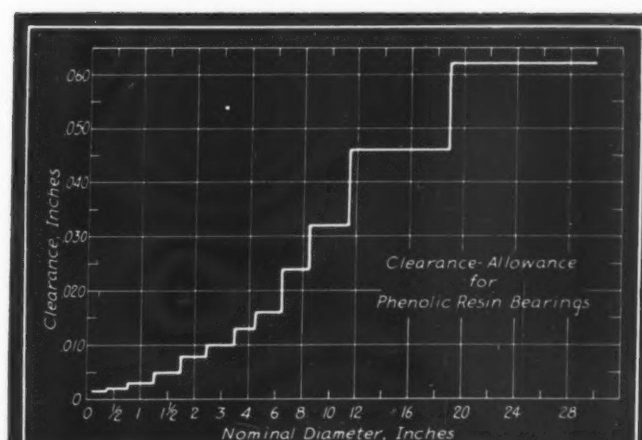


Fig. 11—Tolerances such as these have been found to be very satisfactory on plastic bearings

A machine used for printing the safety marks on safety check paper, using delicate shades of water-soluble ink in dilute solution, had antifriction bearings installed on the ink feed rollers. Under normal operating conditions at the quite high speeds involved, the bearings seeped a small amount of oil which found its way into the ink and then to the feed rollers where it left greasy spots which prevented the rollers from picking up their normal supply of ink and thus

causing misprinted paper and a considerable wastage of product. In addition to this, the constant splash of the ink eventually worked its way into the bearings, resulting in high maintenance costs.

Printing Ink Lubricates Bearings

These bearings were replaced with water-lubricated resin bearings with the idea that a slight amount of water leaking into the ink would do no particular harm. It was found, however, that the splash over a long run diluted the ink to such an extent that the product was not uniform. The water lubrication was then discontinued and the ink itself was forced over the bearings for cooling and lubricating and this has worked perfectly. Over a period of three years the bearings have worn only a few thousandths of an inch and are trouble free.

TABLE II

Resistance of Plastic Resin Bearings to Common Chemicals

Acetic acid, 10%	Attacked	Naphtha	No effect
Acetic acid, Conc.	Attacked	Nitric acid, 1%	Attacked
Acetone	No effect	Turpentine	No effect
Ammonia	No effect	Oil, mineral	No effect
Ammonium hydroxide	Slight effect	Oil, organic	No effect
Benzol	No effect	Potassium hydroxide	Attacked
Carbon tetrachloride	No effect	Sodium chloride	Attacked
Copper sulfate	Attacked	Sodium hydroxide	Attacked
Ether	No effect	Sodium sulfate	Attacked
Ethyl alcohol	No effect	Sulfuric acid, 5%	No effect
Ferrous chloride 5%	Attack	Sulfuric acid, 50%	No effect
Hydrochloridic acid, 20%	Slight effect	Sodium sulfite	Attacked
		Zinc chloride, 50%	No effect

TABLE III

Effect of Some Common Working Conditions On Plastic Resin Bearings

Age: Not affected, except that there is a slight increase in hardness.

Heat: Not readily flammable. Will withstand 275 degrees Fahr. continuously.

Moist air and steam: Absorbs slight amount of moisture.

Weak acids: Practically impervious.

Strong acids: Decomposes, rapidity depending upon strength of solution.

Weak caustic alkalis: Does not successfully resist unless very dilute.

Strong caustic alkalis: Completely destroys. Rapidity depends on strength.

Oil: Not affected but absorbs slight amount.

Rubbing: Polishes and hardness increases, color darkens considerably.

Coarse grit: Wears rapidly.

Fine dust: Very little effect.

With the newer odorless resins, many items of equipment handling liquid or semi-liquid food products may be provided with resin bearings and a part of the food product be first used for cooling and lubricating prior to being processed in the machine, thereby eliminating all danger of contamination by oil seepage or water splash. Several examples of this are machines used in processing food oils, vinegar, syrup, milk, etc. Upon completion of a run the entire machine may be washed and steamed without damaging the bearings in any way.

Presents Reaction to Chemicals

In the chemical industry plastic resin bearings also find a place, and their characteristics when acted upon by some common chemicals form the basis for TABLE II, while TABLE III presents the effect of some common working conditions on the bearings.

It is necessary that certain considerations of design be faithfully followed if best results are to be had. Failure to give these principles their proper weight commonly results in an inferior bearing and often in complete failure. The clearance allowed for the running fit is probably the most important single factor of design after provision for the removal of the heat of friction has been made.

Must Allow Sufficient Clearance

If a phenolic resin bearing were to be installed allowing only the customary clearance for a metallic bearing, it would fail in a short time for reasons previously explained. In addition to the swelling of the bearing by absorption of the lubricant, the shaft increases in diameter due to thermal expansion. The bearing also is affected by temperature to cause enlargement. With the bearing restrained on the back, all of the expansion acts to reduce the bore. Unless plenty of clearance has been allowed to offset this, a pinched bearing and incineration of the bearing is the result. *Fig.* 11 indicates tolerances that have been found to be very satisfactory and ones which provide good running fits on plastic bearings. When bearings are first set up using these tolerances, they will seem quite loose, but after a short running-in period they will be found to be a good fit.

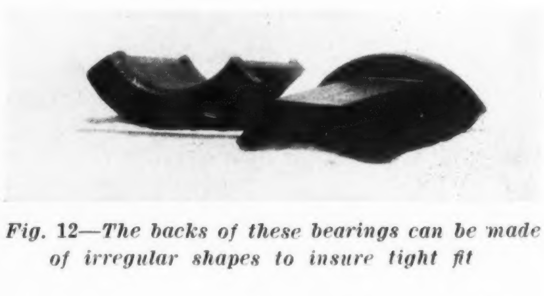


Fig. 12—The backs of these bearings can be made of irregular shapes to insure tight fit

It is always necessary to use the larger sizes of plastic resin bearings in segments with arcs of contact of less than 240 degrees total for the two halves of the bearing. This allows 120 degrees of the shaft surface exposed to the action of the coolant-lubricant which should be water if possible. Bearings smaller than 3 or 4 inches inside diameter may be made of two 180-degree segments, or even a single 360-degree sleeve if a hole or window of generous size is cut on the nonpressure side of the bearing to allow the coolant to contact the shaft readily.

In this connection it should be noted that it is not sufficient merely to admit the coolant—some means must also be provided for it to leave the bearing. In other words it must flow through the bearing thus carrying the heat away from the shaft. It is customary to make this window in the bearing equivalent in length to three-fourths the length of the bearing, and for it to include in width at least 90 degrees of arc. It should be remembered that the problem is one of heat transfer and the window should have sufficient area to accomplish the desired result without difficulty.

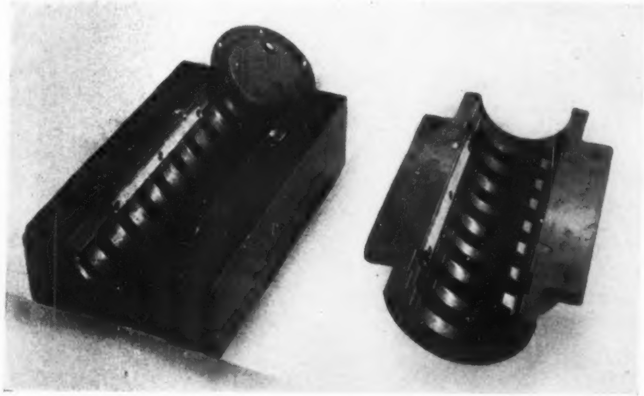


Fig. 13—Typical marine type thrust bearings of phenolic plastics for use in a paper mill engine

Grooving Insures Lubricant Circulation

Another method of insuring circulation of the lubricant within the bearing, when small 360-degree bushings are used and the loads are light, is to groove them somewhat as shown in *Figs.* 1 and 4. (M. D., Sept. pp. 34 and 35). However, grooves are never to be used in the case of large oil or water-lubricated bearings where the loads are heavy or the speeds high, as they do not provide sufficient area for cooling purposes and act to interrupt the lubricant film.

Many expedients have been devised for securing plastic resin bearings in place in their chucks or sleeves. In the case of bushings, a light push fit is all that is necessary as their subsequent swelling is sufficient to hold them tightly. When two 180-degree segments are used in a split box, the shims may extend between the bearing halves to prevent their rotation, or the segments may be held in place with dowels of the resin material. When segments smaller than 180 degrees are used, retainer strips may be bolted along the upper edge or keys may be inserted into slots milled axially into the back of the bearing and the inside of the chuck. The dowel method may also be employed. Under no circumstances should this type of bearing be installed with brass dowels or with flat head brass screws which may come in contact with the shaft. Phenolic plastic bearings will not operate satisfactorily with water lubrication in conjunction with even small areas of brass in contact with the shaft.

Molds Are Economical with Large Numbers

If more than about 40 or 50 bearings of a size and kind are to be used, it is more economical to have a mold made, and to mold a pair of keys on the back of the bearing to fit into suitable milled grooves in the chuck or bearing, *Fig.* 10. In case this is not desirable, then the back of the bearing can be made of some irregular shape as shown by *Fig.* 12.

The securing of the bearings into the chucks may be done in one of the ways described in the foregoing or in other ways which the ingenuity of the designer may suggest. It should always be borne in mind, however, regardless of the method used that under adverse conditions the starting friction may be very high, and the bearing retainers should be of such size that they may absorb a load equivalent to about 0.25 of the starting load per bearing. Bearings made of a section of phenol plastic material in conjunction with a section of metallic bearing will not function satisfactorily and should be avoided at all times.

Retainer Strips Prevent Rotation

Fig. 13 illustrates a marine type thrust bearing for use in a paper mill jordan engine. The shaft size is about 6 inches and the bearing 24 inches long composed of two segments each of which is 135 degrees. The bearing is held against rotation by the retainer strips bolted along the sides, and the thrust loads are transmitted to the chuck by the radial keys molded in place on each segment and fitting into mating grooves cut into the chuck.

As a general rule, the manufacturers of these bearings maintain engineering staffs for the purpose of assisting prospective users of these materials to select a type of bearing which will be most suitable for the intended use. It is therefore possible for a designer to obtain precise data for specific uses very easily. These engineering staffs have had long experience and their recommendations should be very carefully considered by the designer.

THE END

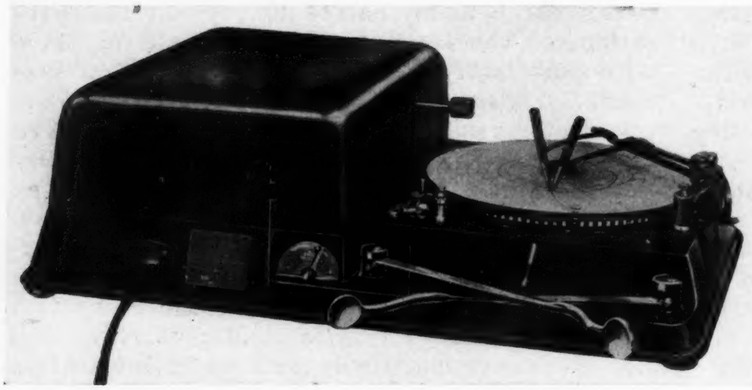


Fig. 1—Unique machine mechanically multiplies three values, two of them square roots of the numbers given, and indicates the product

Integrator S
Complex E

By Charles B. Johnson

COMPLETELY accurate results are, above all else, the ideal of every engineer. So it is little wonder that some of the most interesting and unique mechanisms are to be found in computing machines, machines which demonstrate by their actions the real enthusiasm of their creators. These machines give results accurate beyond all hope of duplication by human calculators; produce these results at undreamed of speed; and considerably simplify the routine calculation procedure. An example of such a machine is the Emco-McGaughy integrator of *Fig.* 1. This machine multiplies three given values of a chart—time, square root of pressure, and square root of differential—and sums up the product on a revolving counter in terms of cubic feet of gas.

The integrator, built by Pittsburgh Equitable Meter Co., is designed to facilitate the calculation of the total extension of orifice meter charts. With these charts, pressure and differential curves are employed as indices for the determination of the quantity of gas passing through an orifice during any determined period. With the inspection method of chart calculation, certain theoretical discrepancies exist due to taking the square root of average values over finite time intervals whereas the formula calls for instantaneous square root values. Also, some error is encountered as the meter pressure and differential pens never track on exactly the same time arc of the chart, therefore there is always some time lag which is not taken into account with the inspection method. The integrator eliminates the time interval compromise and, furthermore, each instantaneous value of pressure is synchronized with its corresponding value of differential.

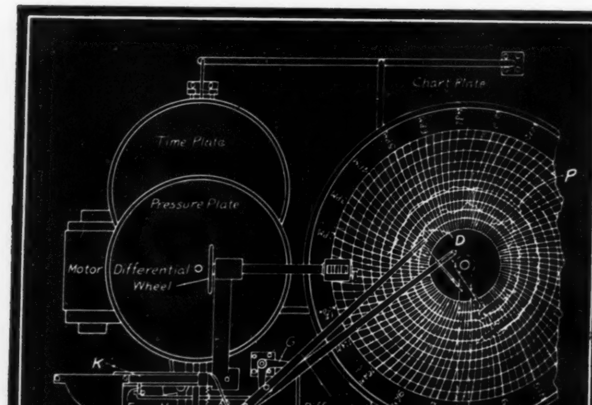


Fig. 3—Differential wheel is shiftable to accommodate varying factors in the equation

Instantaneous Multiplication Made

The mechanical multiplication of constantly varying factors as represented by chart lines can be readily accomplished by the creation of followers for the chart lines which co-operate with wheels and plates in such a manner that an instantaneous change in the distance of one of the wheels from the center of a rotating plate will produce an instantaneous multiplication result for the revolutions of the wheel shaft. This result can, of course, be recorded on a simple counter. However, in this machine the problem is not simple multiplication. Two square root values enter into the computation, and the position of the wheels from the center of the plate must correspond to these square root values rather than the straight mathematical value.

Despite this complication, the machine of *Figs.* 1 and 2 is comparatively simple. Essentially it consists of three disks or plates which may be termed the chart plate, the time plate and the

Solves Equations

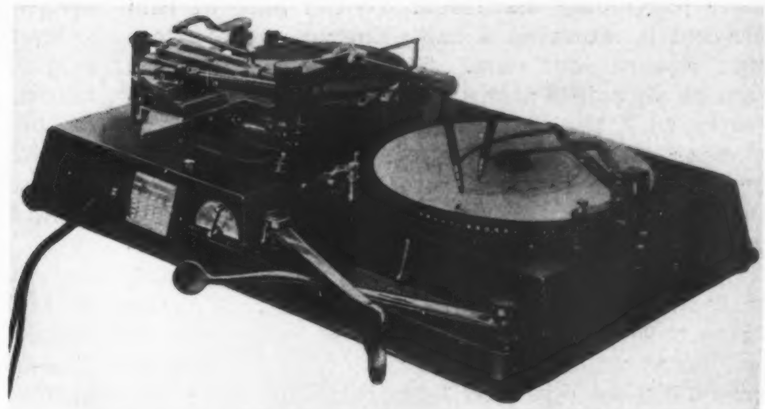


Fig. 2—Conveniently placed handles permit the operator to follow the lines of a recording chart as it comes from the field

pressure plate. The time plate and chart plate are geared together in constant ratio and are driven by a variable speed motor. The pressure plate is situated above the time plate and geared to the pressure plate shaft is a small steel disk roller termed the pressure roller. A second roller, termed the differential roller, is mounted on the pressure plate and is direct connected to a simple revolution counter.

The exact operation of this computing device starts with the original chart and following pens as shown in *Figs.* 2 and 3. (Although the relative positions of the parts are not the same in the photographs and drawings, and some minor variations have been introduced into the photographed machine for ease of operation, the principle of operation is the same.) Rotation of the chart plate, *Fig.* 4, is controlled by the variable speed motor through a geared connection.

Elements Had To Be Shiftable

At this point in the development a mechanical problem was introduced. It was necessary in the computing mechanism to mount two rotating plates and two rotating wheels, and one of the plates and one of the wheels—the pressure plate and pressure wheel—had to be geared together. Further, two of the four elements had to be shiftable to accommodate the changes in the pressure and differential lines on the chart. Inasmuch as the pressure plate and wheel are the only two of the four elements geared together, the design could be simplified by making these two parts the stationary parts. This, of course, necessitated a shifting arrangement for the time plate without disturbing the relation between its speed and the speed of the chart.

Such a driving relation is maintained by arranging the shaft of the time plate, *A* in *Fig.* 5 (a view through *Y-Y* of *Fig.* 4) to co-operate with splines *B* of the motor drive worm so that bracket *C* can be shifted to any point along shaft *A*. The other shiftable element is the differential wheel of *Figs.* 3 and 4.

It is the shifting of these elements which introduced the most complicated design problem. As before noted, the following pens must cover all of the deviations of the chart lines. It would require a most complicated mechanism to make these pens follow the chart lines through a direct mechanical connection and still move the wheel or plate through this mechanical connection a distance that would correspond to the square root value of the chart figure.

This problem has been overcome by abandoning direct mechanical connection between control levers, wheels and pens in favor of an indirect method which shifts the position of the wheels and co-operating square root cams and leaves the pens, as controlled by spring-retained followers on the cams connected through linkages with them, to follow the chart variations. Thus the control arrangement is changed from forcing the pens to follow the chart lines to permitting them to follow the lines by allowing a change of position of the cam followers.

Tracing this movement first with the pressure line, *P* in *Fig.* 3, the pressure lever controls a rocker arm, *Fig.* 6, (a view through *X-X* of *Fig.* 4), connected through linkages with movable bracket *C* on which is mounted the time

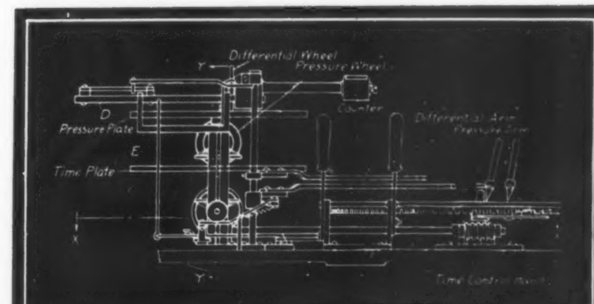


Fig. 4—Time control handle shown stops the unit after a predetermined period

plate previously discussed. To the base of this bracket is mounted a cam, known as the pressure square root cam. The elevations of this cam at all points along its height correspond directly with the square root of the distance as measured by the movement. Movement of the bracket and the cam shifts the time plate so that the distance from the center of this plate to the pressure wheel, and the consequent multiplication of speed of the shaft of the pressure wheel, is directly proportional to the square root of the value of the pressure line.

The amount of shifting is, of course, governed by the pressure line which must be followed by the pen. With the pressure arm

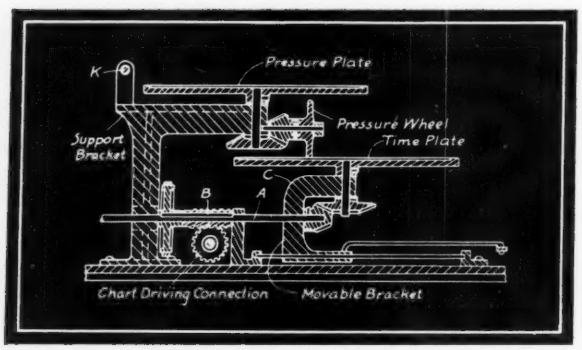
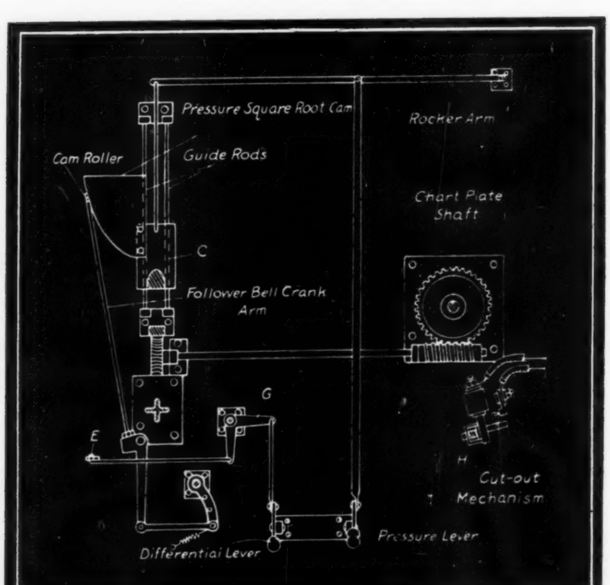


Fig. 5—A splined shaft maintains exact driving relation between parts

Fig. 6—Pressure square root cam controls setting of movable plate



mounted loosely on its standard and directly connected through a bell crank and linkages to the cam roller of *Fig.* 6, it can be seen that to make this pen follow the chart line it will be necessary to shift bracket *C* only as much as the square root of the value of the chart line.

By these steps we have a multiplication of the first factors in the equation, instantaneous time values and the square root of the pressure value.

The final step before the counter can register the exact numerical answer to the problem is the multiplication of the product obtained by the square root of the differential value. In this case, the same general arrangement is used. To state the problem, we have the pressure plate by its rotation giving the previously discussed product. Co-operating with this plate is the differential wheel which must be regularly shifted a distance which will be proportional to the square root of the value of the differential line, *D* in *Fig.* 3.

The shaft of the differential wheel, *K* in *Figs.* 3 and 5, is mounted on the stationary support bracket. A pendant arm, *E* of *Fig.* 3, affixed to this shaft, is connected through bell crank *G*, *Fig.* 6, to the differential lever. Shifting of this lever will thus shift the shaft so that the differential wheel is moved away from or toward the center of the pressure plate. Also affixed to the shaft is a differential square root cam, the rise of which is followed by a cam roller directly connected through linkages to the pen following the differential line.

Multiplied By the Square Root

As in the previous case, the rotations of the pressure plate and the consequent reading on the counter, are multiplied by the square root of the value on the differential line as mechanically determined by the position of the differential wheel in relation to the shaft of the pressure plate. Thus, the counter registers only the exact results of the complicated equation, yet registers this result at instantaneous time intervals.

A refinement in the design of the machine is the provision for automatically limiting the time period for which the value of the extension is to be computed, whether for the duration of the entire chart or for any portion of it. The manner in which this is accomplished is as follows: A time control handle, *Fig.* 4, bearing on the shaft of the chart plate, extends to a point beyond the rim of the plate. This handle is composed of spring steel, and tends to spring toward the bottom of this chart plate which has a pendent circular flange that is divided into a plurality of teeth with which a lug on the handle is engageable to maintain a given setting.

The handle also has a bumper which will ultimately engage a fixed stop, *H* of *Fig.* 6, to stop the machine. The bumper has an associated cut-out mechanism comprising a plunger and a fixed contact with which the contactor ordinarily engages. The approach of the bumper will operate the cut-out and then apply the brake, whereupon the chart plate will come to rest.

Oil Pressure Regulates Propeller Pitch

CONSTANT speed propellers are now coming into such general use on the airlines both here and abroad, have such interesting mechanisms, and are being included in the design of so many new airplanes for military and commercial service that the presentation of the means of operation, as abstracted herewith from the *Bee-Hive* of United Aircraft Corp., will no doubt be of interest to all designers. The primary function of any constant speed propeller is to permit the engine to run at desired RPM regardless of altitude or forward speed of the airplane. This is important not for propeller performance but for engine operation, since power depends on both the RPM and the throttle opening. The constant speed propeller makes possible the control of engine speed independent of the throttle.

This is accomplished by automatic change of propeller pitch. In the Hamilton Standard design the pitch is shifted by oil pressure, the propeller itself being basically the same as the Hamilton Standard two-position controllable, described in the April, 1932, issue of MACHINE DESIGN, p. 33. Counterweights acted on by centrifugal force provide the operating force to move the blades toward high pitch, and the oil pressure works in the opposite direction against the counterweights.

Pitch Is Automatically Selected

With the new control, pitch is automatically selected by a separate unit called the Constant Speed Control which regulates the oil pressure in the propeller operating cylinder. A simple gear pump in this unit boosts the engine oil pressure up to 180-200 pounds per square inch where it is maintained by means of a relief valve. Although considerably less pressure is normally required to shift pitch, this comparatively high value is desirable to give responsive pitch changing action.

The sketches indicate propeller, constant speed control, and booster pump in their associated relation for three different operating conditions. The first, "Underspeed", *Fig.* 1, is the case where RPM is less than that desired,

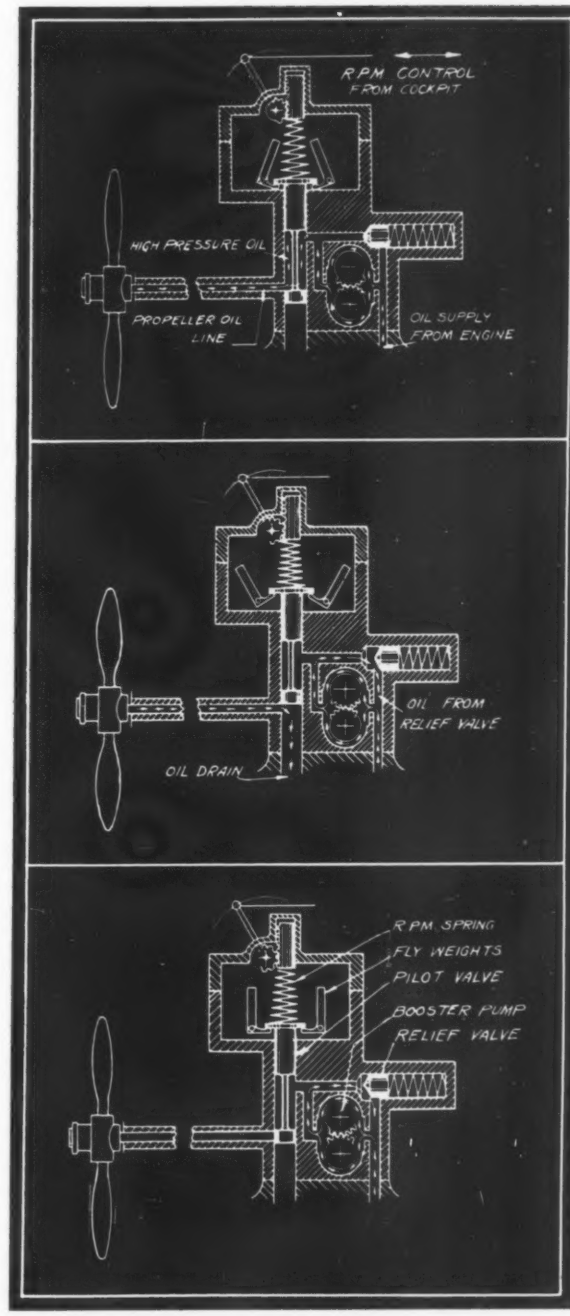


Fig. 1—Top—When port to feed line is opened as shown, speed of flyweights is changed by oil pressure and propeller pitch shifted to correct setting. Fig. 2—Center—Arrangement when speed is higher than desired. Fig. 3—Bottom—This is the correct setting for predetermined speed

such as occurs momentarily when the airplane is pulled up into a climb, or when the throttle is moved to a partially closed position. The second, "Overspeed", *Fig.* 2 is the case where

(Concluded on Page 107)

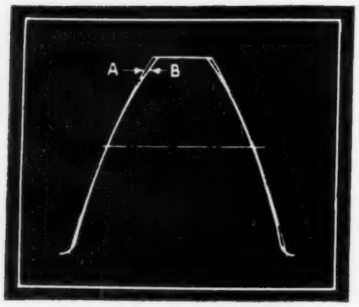


Fig. 1—This practical tooth curve has a number of advantages over mathematically exact involute at A

Gear Noise—Reduce It at Its Source!

By W. P. Schmitter

THERE is no single controlling factor for gear noise and there are little in the way of criteria upon which to forecast performance. However, the designer can do a great deal to eliminate noise by proper selection of gear contours as Mr. Schmitter, assistant chief engineer, Falk Corp., points out in this article, abstracted from a paper presented before the Gear Manufacturers association.

INTRIGUING problems involved in the design and production of quiet high speed gearing are exacting the attention of practically all engineers concerned with gears and speed reducers. This may be explained in part by the insistence of the operators and general public for relatively silent machinery. Unfortunately, however, it is not always possible to anticipate the character of noise to which exception will be taken, to say nothing of the lack of instruments suitable for identifying or measuring it.

Disturbances which are the cause of noise must be eliminated at their source. This is possible only when dimension and form is held to such limits as will insure the presence of no motion other than the prescribed one.

Noise in gearing is to a large degree the result of recurrent separation of the contacting teeth. It is only possible for such separation to exist when any instantaneous value of relative angular velocity differs from the *mean* values established by the prescribed velocity ratio of the set.

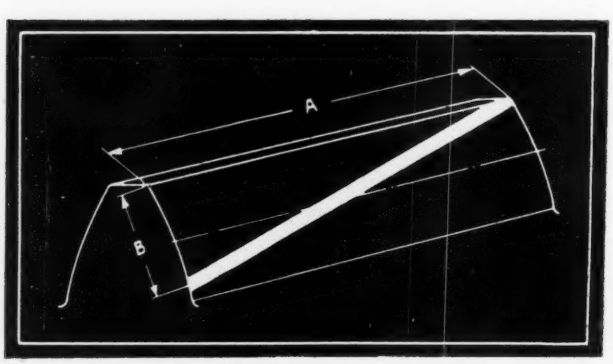


Fig. 2—Low helix angle loading toward the tip gives correspondingly high deflection

The causes for tooth separation are frequently, but not necessarily, due to imperfections in the gears themselves. However, they may be due to outside conditions which have little or nothing to do with accuracy of gear cutting or design.

A pair of gears is essentially a loosely coupled device. The running clearance between the teeth is necessary to provide room for expansion with increase of temperature and to permit proper lubrication. It is largely because of this clearance that adverse external conditions sometimes interfere with the proper performance of an inherently good gear set.

The primary kinematical requirement for gear tooth action is that the common normal to the curves at their point of tangency pass through the pitch point. The involute satisfies this condition in theory and, if we were dealing with rigid materials and perfect tooth forms having no clearance, spur gears of that type would transmit perfectly uniform motion. Because of inaccuracies and elastic distortions which prevail in practice this ideal is not attained.

Fig. 1 shows a tooth curve which has a num-

ber of advantages over a mathematically exact involute. The theory upon which this is based is that not only are interferences in tooth action avoided, but in addition highly desirable compensating effects are obtained under the elastic yielding which takes place under load.

Use Care in Applying Modifications

In spur gears such modification must be applied with extreme care because an overdose is productive of the same evil. A few tenths of thousands is all that can be permitted. In a helical gear properly designed, all phases of tooth action are present at one time. With sufficient overlap, continuity of motion is assured by the helical trace and considerably greater involute deviation is possible. Herringbone gears having an exaggerated degree of divergence have been produced for many years. This was incidental to the use of hobs having straight sided sections in the normal plane. No attempt was made to control the amount of deviation which depends mainly on thread angle, position of hob relative to blank and tooth height. As a consequence some gears had far too much, particularly the heavier pitches, with the result that load concentration at the pitch line was excessive.

By manner of composition all of the possible phases of spur gear action are simultaneously produced to obtain the uniform motion of helical gearing. It is generally assumed that if a little more than one axial overlap is present, full helical action is present. It can be shown that this is not always true. *Fig.* 2 shows a low angle helical tooth loaded in the characteristic fashion. At one end the loading is toward the tip with a correspondingly high deflection and at the opposite end it is toward the bottom with very low deflection. It is quite conceivable that under load one end of the tooth will yield a varying amount thus causing some angular distortion of the transverse contact planes with each other. Low helical angles are therefore not particularly well adapted to high speed gearing.

Design Controls Velocity Variations

Fig. 3 shows the nature of contact on a high angle helical tooth. The base helix angle and the slope of the plane of contact is considerably increased. A little reflection will convince one that if the ratio of A to B is small, the tooth will react substantially as though it were loaded at the center. If, on the other hand, this ratio is high, one end of the tooth receives but little support from the other. It can be seen, therefore, that while helical gearing mitigates the effects making for velocity variations in spur gears, that unless the gears are properly designed, its full possibilities will not be developed. Although circumstances will alter cases a heli-

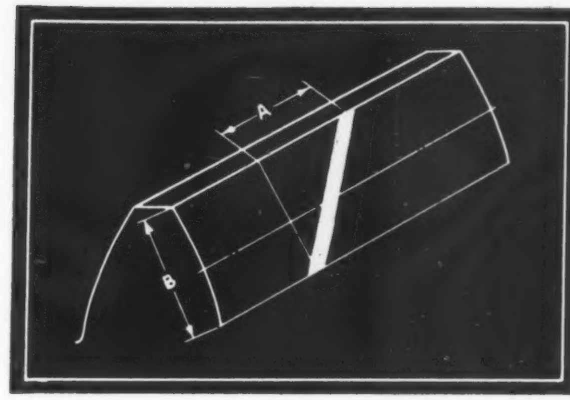


Fig. 3—Nature of contact on a high angle helical tooth, slope of contact increased

cal angle of twenty degrees or more should be used. Beyond that point the law of diminishing return seems to apply.

Because of the elastic distortions of the teeth, there may still be present in helical gearing some of the characteristic action of spur gears. As a result of the variations in deflection there exists a similar variation in stress intensity and deformation at the contacting profiles. Since the amount of load carried by the teeth in any particular transverse plane changes with the position of the engaging teeth there must be a transmission of energy and stress axially from one plane to another. If we consider that these gears are moving at high velocities and that these adjustments and readjustments must take place continuously and at a tremendous rate of speed, we get some conception of what is happening during load transfer in high-speed gearing. There is reason to believe that for this class of work energy propagation should be confined to as small a limit as practical.

May Utilize Extremely Rigid Tooth

Two methods of treatment suggest themselves. An extremely rigid tooth may be utilized in order to reduce deflections to a minimum. This involves the use of a high pressure angle. The other course is to maintain a more uniform load distribution in each transverse plane, thus reducing the need for reinforcement in other planes at the instant of tooth transfer.

Fig. 4 illustrates the variation in the length

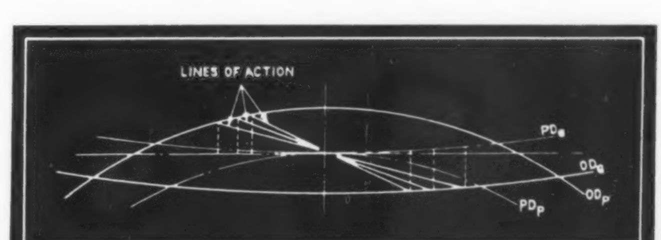


Fig. 4—Variation in the length of line of action with several arbitrarily chosen pressure angles

of line of action with several arbitrarily chosen pressure angles. If the outside circles of gear and pinion are adequate a pressure angle can be selected so that for all ordinary conditions the requirement of approximately two teeth in contact will be met. It is apparent from *Fig.* 5 that a higher tooth may be obtained with low pressure angles than with high ones. A reasonable top land is needed in order to avoid fracture at the tip of the tooth.

Provides for Integral Contacts

The development of the Cox theory marked an important gear advance, not so much because of its direct application but because it has focused attention on the extremely important subject of contact cycles. As is well known the Cox theory provides for integral contacts in either, or both, the circumferential and axial planes, this result being obtained by choice of tooth height, pressure angle, helical angle and face width. It has been found in helical gearing that it is extremely difficult, if not impossible to obtain strictly integral contact, even in the axial plane. The bending of the teeth and variation in the deflection at the point of contact, together with errors in manufacture, are largely responsible for the difficulty encountered in attempting to achieve this ideal. These practical considerations are enough to make appreciable difference between the theoretical and the actual contact ratios. The turbine tooth form has been developed particularly for high speed gearing. Proportions are so chosen that there are slightly more than two teeth in transverse contact at all times. No attempt is made to modify any of the constants to suit the requirements of individual applications except that the number of teeth in the pinion is not below a certain minimum. While standard forms are rigidly maintained, the number of teeth in contact is only slightly greater than two even with large numbers of teeth in pinion and gear.

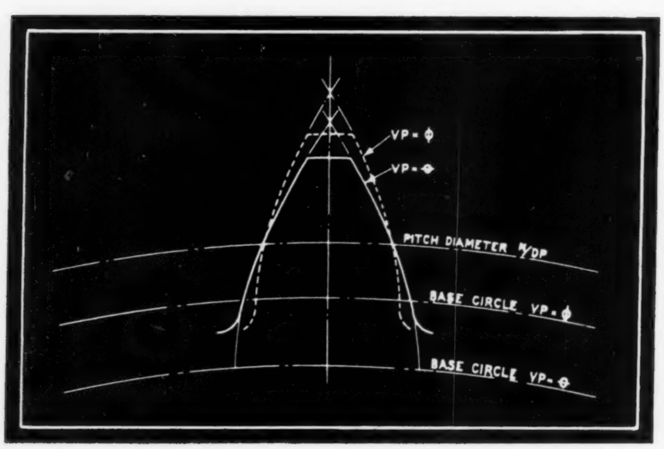


Fig. 5—A higher tooth may be obtained with low pressure angles than with high ones as diagram shows

Metal Congress To Feature Materials and Finishes

IN A year featured by aggressive improvement and sustained interest in exhibitions of machines, parts and materials, the National Metal Congress opening at Cleveland October 19 promises to include displays of even greater value to engineers. Materials will be, of course, the main theme of this exposition, but grouped around these basic exhibits will be scores of displays of machines for working the materials, finishes for protecting them, units for welding, and other associated fields with which the designer should be acquainted.

Of especial interest will be the many finishes, surfaces and inserts for the lengthening of material life and the protection against unusual forces which might act against the machine part. One of the newest will be the dichromate film coating for the protection of zinc die castings. Another booth will house a working display of cadmium plating which will illustrate the results obtained by the process. More severe forces can be resisted by the hard surfacing with welding rod or electrode. Many varieties of metals so deposited can be inspected at this exposition. Or, the designer will be able to obtain information on cemented carbide inserts which will give his part exceptional resistance to wear and abrasion.

To Show Sweat-On Overlays

A process which is not so well known is that of sweating overlays on base metal to furnish abrasion resistance. Actual demonstrations of the furnace procedure in the application of these steels of different analyses will be made throughout the show.

In the field of welding and torch cutting, a welder will be shown with a control which makes possible the selection of any degree of arc penetration for each current setting. Other arc welders of vastly improved design over those shown just a year ago, and the latest developments in arc welding electrodes will be demonstrated. Outstanding developments in the oxy-acetylene process will also be presented, as will the latest cutting machines which enable the process of torch cutting to be put on a production basis. Several new acetylene generators which have been introduced during the past few months will be shown, and a new line of oxygen and acetylene regulators will be represented together with the latest in hand cutting and welding blowpipes.

At all of the booths the designer will find experts in each particular field, experts willing to discuss the particular design problem in detail and to assist in the solution which will be of greatest advantage to the proposed machine.

Highlights of welding—and a glance into the future—are presented in this supplement to Machine Design's October issue.

MACHINE DESIGN has published an article on welding development every third or fourth issue since its inception. Even with this seemingly complete coverage, however, it has been difficult to keep pace with welding progress due to the constantly-recurring improvement in the art and to the increasing momentum of application of the process in design.

TO BRIDGE the gap and jump a step ahead, this Welding Section is presented as a supplement to the October, 1936, issue. It has been the aim of the editors to include in this special section only those contributions that will serve to enrich the knowledge, and in many cases supplement the actual experience, of executives and engineers responsible for design work.

THE special section can be readily filed for reference. It is stapled as a complete unit in itself into the center of the magazine, thus permitting removal of the section without damage either to it or to the magazine proper.

Over the Horizon!

By Robert E. Kinkead
Consulting Engineer, Welding

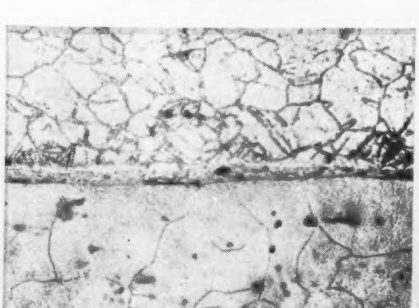
THE idea of a solid continuous metal machine part built up of a number of details welded together is illustrated by many of the most modern machines. Rapid development of new welding processes and technique have opened another vista to the progressive designer in the direction of welding together an assembly of separate details into a solid continuous structure in which each detail is of a kind of metal or composition best adapted to its particular service requirements. Thus, welded steel gear blanks are made in which the rim is perhaps .40 per cent carbon steel, while the web and hub may be in the .15-20 per cent carbon range. And, certain shafts which work in stuffing boxes have deep bronze surfaces applied by welding rather than bronze sleeves attached by mechanical means. A bronze lining applied by welding to the cast iron case of a centrifugal pump for better service life in "bad water" conditions has come into widespread use.

Such practices are of interest to the machine designer and to the metal working industries as a whole because of the far-reaching changes they seem to forecast in the use of metal for machinery and equipment made of metal. From the original conception of a machine part made of separate details welded together, the trend is in the direction of making the machine part an assembly of separate details welded together in which each detail is of a metal and composition best suited to the service requirements at the locality at which the service is delivered. That the desirability of different compositions at different locations has been recognized before is shown by work which has been done to make the rim of a cast steel car wheel of different composition than the center by purely foundry methods. This would seem to indicate that progress along these lines has been retarded by lack of means of accomplishment rather than failure to recognize the advantages.

A machine part may be of heterogeneous metal composition in several different ways.

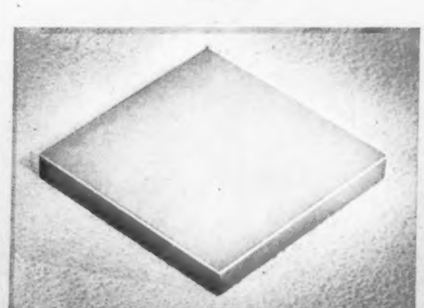
1. The surfaces of the metal may be different from the body.
2. One element of the body of the part

COMPOSITE . . . . . Stainless clad is a development which has reached the commercial stage



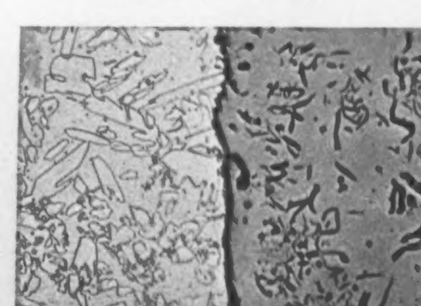
Courtesy Ingersoll Steel & Disc Co.

NONCORROSIVE . . . . . Nickel, bonded to steel, resists destructive forces

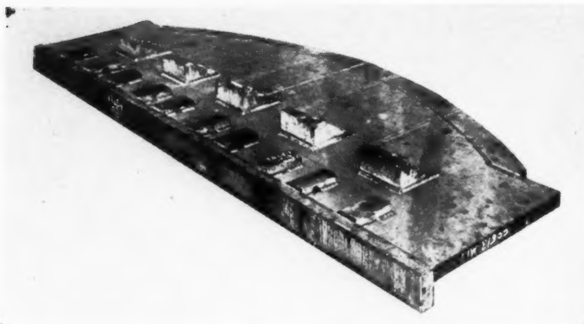


Courtesy Lukens Steel Co.

BOND . . . . . Bronze, left, and cast iron, right, can be securely joined through welding



Courtesy Union Carbide Co.



Courtesy Westinghouse Electric & Mfg. Co.
ASSEMBLY . . . . . Two thousand-ton press frame, fabricated by arc welding, indicates ability to join many details

may be different from other elements.

3. The part may have any combination of surfaces and body elements.

Metal Surfaces

The most typical case of composite metals in which the surface is of different composition than the body is that of the "hard surfaced" part. The accompanying illustrations show examples of Carboloy applied to softer steel for machine parts. Stellite, Stoodite, Blackor and other commercial alloys are applied by fusion to produce a surface which is not only hard but, when applied to a considerable depth, has sufficient resistance to crushing to support a cutting edge at the surface. Considerable use of such hard surfaces has been made in the automotive industry on die blocks of relatively soft metal. The practice is so well established as to require little comment. Hard surfacing was a forerunner of composite metals, in which the surface is different from the body of metal used in a considerable amount of process machinery. While some of such machinery can stand the expense of solid alloy construction, much of it cannot. Thus, nickel, one of the very useful semi-precious metals, is now used extensively as a material which is clad on to ordinary low carbon steel. Copper clad steel is relatively old. Stainless clad is a development which has reached the commercial stage in the quite recent past. The ideas underlying these uses of composite metals is considerably different than in the case of composite metals made by electroplating one metal on another. In the first place, electroplating is a process which deals with the deposition of pure metals. Second, electroplating a surface having a depth of more than a few thousandths of an inch soon passes out of the bounds of permissible cost. Tin plating by the commercial process is in the same general classification.

CHEMICALS . . . . . Caustic soda solution is resisted by this unit welded from nickel-clad steel

Courtesy Lukens Steel Co.

New Combinations Are Forecast

While the machine designer is not ordinarily concerned with the making of the metals he uses in the construction of machinery, the fact that the general background of use of composite metals has led the metal producers into serious exploration of new methods of production not only forecasts the fabrication of new combinations of metals but also much lower cost. Tangible results in this direction will place at the disposal of machine designers composite metals which will very likely change the appearance of many machines, to say the least.

Accumulated experience with some eleven welding processes has made composite metals possible to the steel producer. Between the ingot stage and final slabbing operations, the metal may be built up into a composite of practically any metals having temperature characteristics which will permit hot rolling together. Alloys which are too expensive to use in the solid stage may become common as a surface component of the base metals.

Varying Composition of Body of Metal

While the idea of varying the kind of metal in the body of a continuous metal structure may seem startling at first, recent studies in stress distribution in machinery parts as shown by the pictures of many photoelastic specimens published in recent technical literature, supplies a background which supports the belief that there is a necessity for such practice. The behavior of a machine part is a function of the behavior of the most highly stressed area in the part. After that fails the service history of the part ends until a welding repair has been made. There is no particular point in some cases in making a welded assembly from steel having a yield point of 60,000 pounds per square inch when only 10 per cent of the metal is ever stressed higher than 10,000 pounds per square

inch. But there is certainly a good reason for putting the high yield point metal in the 10 per cent area where the stress may, due to stress concentrations from change of contour or other causes, run as high as 40,000 pounds per square inch. Welded inserts are as sound design as the idea of making a welded assembly. It is not a particularly radical step to make each detail of a metal best suited to the service required.

Carried to its logical conclusion, the practice of making a welded assembly of different metals and alloys would stop only when the cost of using different materials would be more than to use thicker sections of the same material. Where weight saving is an important factor, alloy inserts would appear most advantageous. There are also other factors to be considered; under certain circumstances welding cost varies almost as the square of material thickness.

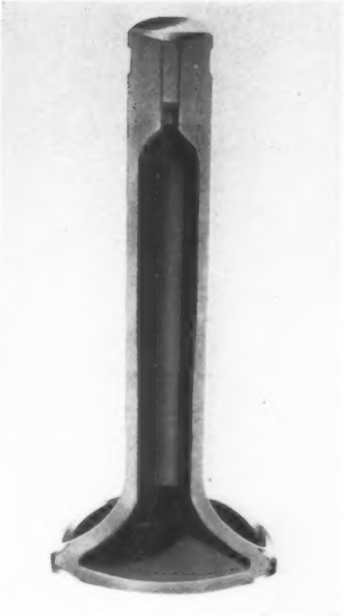
The fact that the trend is towards machinery parts which are composites of several, and in some cases many, alloys is well illustrated in the case of copper hydrogen brazing. This one of the newer processes, which properly belongs to the family of welding processes due to the fact that it depends on molecular cohesion for strength, is used for refrigerator and automotive assemblies of iron alloys of a radically different kind. In some cases the completed assembly is even heat treated. The idea is fading that one alloy when joined to another involves a mechanical joint with crimping, bolting or riveting. Technically it is possible for a machine part to be made of a great many different kinds of iron alloys in a combination with nonferrous metals and alloys. Economically, the number of such combinations which can profitably be used is increasing due to the rapid advances in the science and art of welding.

Integration of Parts in Welded Construction

Another definite trend in welded construction for machinery parts is the integration of small parts into a large welded assembly. Machinery in this country started to be built in small machine shops; often offshoots from foundries, set up to machine and sell finished castings. Being limited as to size of machine tools, these machine shops were handicapped by the size of a casting they could machine. Designers had to take into account the facilities for production rather than the optimum of design. These early machine designers and machine shops were, for the most part, workers in cast iron. Then followed the designers and steel founders who worked with steel castings with the severe limitations of early steel foundry practice. All of these elements in the background of present day machine design practice tended to encourage the use of a relatively large number of parts, machined separately, and bolted together. At the present time, machine designers as a class are tending to go away from these early practices as rapidly as conditions permit. Use of welded assemblies removes limitations which had previously been set by foundry practice. Such difficulties as have been encountered due to warping of large welded assemblies have gradually been overcome. The limitation in many shops is not how large a welded assembly can be made, but how large an assembly can be machined. The heavy electrical industry solved the problem by providing machine tool equipment large enough to machine the largest assembly they would ever want to use and the net result is that welded assemblies are made without any restrictions other than those of putting the machinery together and taking it apart in case of needed repairs.

Invention, improvement, and reduction in cost of use, are the constants which control the design and production of machinery in the United States. Rapid development in the welding processes and their application is bringing up over the horizon a vision of the machinery of the future. It will be a welded composite of many metals and alloys; it will be integrated so that the number of separate parts is reduced to an absolute minimum; its cost of use will be less than it is today.

DEPOSIT—Aircraft motor exhaust valve has hardfacing alloy on the seating surface



Courtesy Haynes Stellite Co.

Courtesy Carboloy Co. Inc.

INSERTS—Wear resistance exactly where needed is provided for textile guide and cam, top, lathe work rest and ceramic die, center, and centerless grinder rests

Why Weld?

WELDING is a production method but planning a product for the application of welding is up to the engineering department. By making it possible to fabricate many things differently and better and by performing operations which previously were difficult or impossible, welding constantly is opening up new design possibilities. The extent to which engineers of well-known companies have been able to take advantages of these possibilities is clearly indicated by the following statements prepared exclusively for this Welding Section of MACHINE DESIGN.

" . . . . . has given us all-steel body."

H. T. WOOLSON, Exec. Engr.

Chrysler Corp.

THE automotive industry is vitally interested in welding, largely for economic reasons. Owing to mass production, permitting many economies and short-cuts in manufacture, the automobile is one of the cheapest necessities we have today on a cost-per-pound basis. The cost-per-pound has been decreased during the past two decades due to the introduction of new processes and savings in both material and labor. To this cost reduction, welding has contributed in no small measure.

Welding is becoming more and more important in automobile frame design. Frame flanges in tension must be designed for net area after the bolt or rivet holes have been removed. Thus, by the use of welding, flange widths may often be decreased throughout their length.

Many types of welding have been developed, thus giving the designer considerable latitude in design. The type of welding may depend upon the type of joint in question; size, gage and form of parts to be welded, equipment, strength required, accessibility, finish, time required, location of operation in the production line and as to whether the weld is in shear, tension or compression.

The types of welding most commonly used in automobile work are, electric, flash resistance, electric arc, carbon arc, projection, spot, atomic-hydrogen and oxy-acetylene. Each type has its advantages and disadvantages for use in a specific problem.

In frame design flash resistance, electric or carbon arc and projection welds are most commonly used. For body and thinner gage work, spot welds, manually or hydromatically controlled, and flash resistance are most commonly used for high production, with electric arc for the inaccessible locations, also for sections that are highly stressed.

It should also be noted that perfection in the art of welding has given us the safety all-steel body. This body, as is generally known, is far more rigid, gives less trouble in service and is more homogeneous and resistant to distortion in crashes than the wooden structure type covered with sheet metal. The development of various types of high speed pinch welders and hydromatically operated spot welding have made it possible to tool the body construction for high speed production.

There is still room for further improvements and development. Welding often increases the expense of finishing various parts, especially in attempting to spot weld exterior body panels which must subsequently be finished. In electric flash resistance welding, the designer attempts to have the shape of the parts to be joined approximately the same; thus it is not possible to butt-weld a rectangular tube perpendicular to the side of another tube.

" . . . . . successfully welding nickel steel."

E. E. GIBSON, Vice Pres. & Chief Engr.

Wellman Engineering Co.

WE HAVE been successful in the arc welding of nickel alloy steels, those of 2 per cent nickel, 1 per cent copper and 0.17 per cent carbon being found particularly suitable for use in the fabrication of our large clam shell buckets, gears and hoisting drums, where-

in a high degree of strength and low weight are essential. This material has a high yield point along with good machinability.

Although this alloy gives very little trouble in the way of air hardening during gas cutting and arc welding operations, all our work is normalized. This is primarily to attain maximum resistance to impact through refinement of grain and other physical improvements.

" . . . . . welding is here to stay."

M. W. LINK, Div. of Research & Development

Crane Company

WE BELIEVE that welding is here to stay and will make greater strides than ever in piping installations. At this time, however, there are limitations to the use of welding for pipe joints and valves. Safety valves, reducing, throttle, blow-off and other similar types of valves, because of their service conditions, should not be welded into pipe lines. Small pipe lines of steel are not yet ripe for welding because of the initial high cost of installation and because permanently pressure-tight joints can be made using screwed fittings. On the other hand, all fittings, certain valves, expansion joints, etc., in the larger sizes can be welded into pipe lines and show a reduced cost of installation over flanged joints, oftentimes.

The great improvements in welding rods, torches and other welding equipment, also the increased skill of the welder in the last few years, has removed considerable of the hazard from the welded pipe joint. All these improvements have placed the welded joint in a position where pressures and temperatures occurring in piping installations are not the determining factor as to the type that will be used, that is, whether screwed pipe, lapped over pipe, or welded connection shall be specified.

" . . . . . welding came at right time."

P. C. DAY, Chief Engr.

The Falk Corp.

DEVELOPMENTS of the welding process came along at about the right time, as such things usually do. During the last few years the rolling mill industry has changed. Most of the important modern mills are of continuous type requiring a long line of powerful gear drives of more or less uniform horsepower with progressively increasing speed. Each drive is individual in character and the group drives for one mill are generally quite different from those required for another. If it had been necessary to build gear frames along the old methods, the cost of patterns and development would have been out of all proportion to the intrinsic value of the drives while the delays involved in making the complicated designs needed for castings and the patterns to follow those designs could not be tolerated.

We have tackled the problem by using a combination of simple steel castings for such parts as bearings, etc. (which can be readily standardized) with welded plate construction. This makes a very flexible arrangement which can be rapidly designed at relatively small cost and put through the shop in the minimum of time. The designs can easily be changed to meet varying conditions and a range of requirements can be met with the same basic designs reproduced with plates of different thickness. I might add that practically all of our large work of this character is now accomplished by a combination of simple steel castings and welded plates, utilizing the best qualities of each.

For certain classes of gear units for warships, demanding extreme rigidity with lightness, we prefer to build frames from highly skeletonized steel castings but this is only made possible because such work is of a repetitive character. However, these units must be considered as partly welded because the openings in the frame are closed by thin sheet steel panels welded to the cast steel frame.

" . . . . . design must anticipate welding."

W. A. HART, Chief Engr.

Colonial Broach Co.

THE question today no longer is "Why Weld?" but rather "Should we design for welding?" Welding must begin in the engineering department. It is not a substitute for other types of construction. If welding is to be used, the design of the machine must anticipate the use of welding.

In the machine tool industry, welding facilitates the use of rolled steel. This is an especial advantage where rapidity of delivery of any of a large variety of models of machines is a major factor, in addition to the well-known advantages of clean modern appearance, great ruggedness (twice the rigidity of cast iron), ease of fabrication, massiveness without bulkiness, elimination of the shrinkage problem, reduced machining costs and lower weight where weight is not essential.

A thorough understanding of the problems underlying and accompanying the use of welding—and a study of each design as to stresses and strains, feasibility of making outside welds, etc.—is absolutely essential in the determination of whether the part is or is not to be designed for welded assembly. And it should be emphasized that proper equipment, proper

facilities and the right man-power must be available before welding can be considered.

" . . . . . progress beyond acceptance."

K. R. Weise, Chief Engr., Tramrail Div.

Cleveland Crane & Engineering Co.

IT IS my opinion that welding has proved to be the greatest single manufacturing tool given in the last decade to aid manufacturers in simplification and improvement as well as modernization of their products. In our particular field we have found welding a great aid in the construction of special buckets, grabs, cranes and other items not possible with riveted construction or with the use of castings with expensive machine work.

It is my belief that welding today has progressed far beyond public acceptance. There are still many prominent engineers and purchasers of machinery and other equipment who hesitate to accept welding and who still prefer the old-fashioned construction, even at an added cost. However, it is my opinion that this reluctance will be overcome within the next four or five years.

True, welding is not always the answer. Many times where large numbers of small parts are involved, it will be found that either steel or malleable castings produced in large quantities and manufactured through production jigs and fixtures will be more economical than equivalent welded design.

" . . . . . cost would be prohibitive."

Peter Hall, President

Hall Planetary Co.

DURING the past seven years we have worked hard to perfect a welded milling machine bed of low carbon steel with machined and heat-treated ways of very hard and tough manganese steel welded to it. At the same time we have tried to get specialists in welding of machine tool frames to make such beds for us at a reasonable cost.

Not only have all their prices been too high but one of these companies, experienced in welding beds for large punch presses, told us that they would not like to make a welded bed for our milling machine because a machine so constructed might not give good finish to its work. They explained that while cast iron has a deadening effect on vibration, similar to that of lead, welded steel might cause singing noise and chatter when the cutter was in action. After thinking all this over we have decided to stick to cast iron beds, fixtures and chucks.

We do believe that if welded beds were properly designed, with heavy sections of special alloy steel which would be free from vibration, they would be much better than cast iron beds. Their cost would be prohibitive, however, and in our opinion it will be many years before this process of cutting up and welding together special alloy plates can be made to compete with the pouring of molten pig iron into a mold.

" . . . . . welding makes better cranes."

W. C. Heinle, Chief Engr., Crane Div.

Cleveland Crane & Engineering Co.

ABOUT 1920 we began the pioneering work in the use of welding in the manufacture of cranes. In 1926 we built the first all-welded steel crane ever constructed. Incidentally this has been in continuous use ever since with a most enviable record of operation. Because of the excellent results with all-welded steel cranes, we have standardized on this method of manufacture. We have a large number of all-welded cranes of capacities up to 200 tons and spans up to 120 feet, in a variety of industries—many in steel mills operating under full load 24 hours a day.

Welding has made it possible to build a much better crane. Here are some of the reasons: (1) Makes possible trouble-free use of roller bearings. With other types of construction connections gradually loosen in service which results in misalignment, causing binding and failure of the bearings; (2) Reduces crane maintenance to minimum as there are no rivets and no bolts except where absolutely necessary for erection and maintenance; (3) Makes cranes unusually rigid because more and stronger connections can be made. For instance, reinforcing diaphragms inside of a girder are welded to both the web plates and to the top plate; (4) Makes possible a faster unit, because of the considerably reduced weight and roller bearings; (5) Provides power savings because all-welded steel cranes with roller bearings usually do not require as large motors; (6) Makes for safety, steel is used throughout with no question of defects below the surface; (7) Makes cranes modern in appearance, lines being smooth and trim.

It must be emphasized that welding was adopted only because it enabled us to build a better product, not because we hoped to lower our manufacturing cost.

" . . . . . welded bases on special machines."

Ira J. Snader, Research Engineer

Ex-Cell-O Aircraft & Tool Corp.

IN THE machine tool industry welding does not play as important a part as in some of the other fields. However there are certain applications where welded steel bases are high-

(*Concluded on Page* 74)

By Howard G. Marsh

Rolled Steel—Basic in Welding!

LAST year 80,000,000 pounds of electric welding rcds were used. On the basis of 25 to 40 pounds per ton this indicates that between 2,000,000 and 3,000,000 tons of steel were welded. Automobiles, buses, street cars, high speed trains, and airplanes all depend to some extent on the satisfactory performance of welds. Welding has become so common that the public accepts it without comment, and in many cases it is actually preferred, especially where general appearance is an important factor.

The magazine MACHINE DESIGN in the last year described 133 newly-designed machines, 19 of which were made of welded rolled steel, 45 had been partially converted from castings to steel, and 69 were still made of castings with no conversion whatever. The machinery and equipment described were of all types and classes

The *American Machinist* for the same period described 263 machine tools, of which ten were made entirely of rolled steel; 14 were partially converted, and 239 were made entirely of castings.

Conversion to Welding Grows

In the field of power shovels and road building equipment, it has been estimated that 50 to 60 per cent of the weight of all the machinery built has been converted from castings to rolled steel. In other lines, such as presses, brakes, electric cranes, and heavy industrial equipment, the conversion has been from 15 to 50 per cent completed. The large electrical manufacturing companies have, of course, gone to the economical limit set by present welding practice.

Notwithstanding all this progress the use of welding in general machine construction is still much restricted, as compared to its ultimate possibilities. There is much to be done before the benefit of this type of construction will be realized to the proper extent. Those who are familiar with this development and have studied its possibilities estimate that the conversion from castings to welded rolled steel for machinery, taken as a whole is only about 15 per cent.

The reason for the apparent backwardness of welded steel in this field is not because steel is an unsuitable material for machine construction. On the contrary, it has all the qualities required for the purpose. It is low in cost, reliable, and available in a great variety of shapes and qualities.

It is not a matter of total cost either, for in most cases where welded construction has been adopted the costs have been reduced. Even if such were not the case, the use of steel would not necessarily be prohibited, for if it does a better job and meets with the acceptance of the buyer it can command a higher price. Steel has replaced wood, cast iron, malleable and steel castings in hundreds of cases where the cost was increased, but its suitability for the purpose made its use advisable.

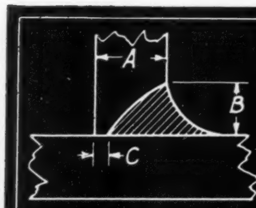
The hesitant progress of welded rolled steel in the machinery field is due to a readily discernible apathy toward welding on the part of many engineers. There are a large number who still regard welding as just a handy tool for the millwright in case something breaks. They hesitate to use welding in the construction of machinery they design, or to advocate its use in the ma-

APATHY toward welding on the part of some engineers is readily explainable by lack of experience with this fabrication method. Mr. Marsh, of Carnegie-Illinois Steel Corp., clearly defines the position of welding and shows how rolled shapes simplify the problem, in this article abstracted from a paper to be presented at a joint meeting of American Society of Mechanical Engineers and American Welding Society at the National Metal Congress.

chines they purchase, because they are not sufficiently informed of its possibilities and demonstrated performance. A little more familiarity with the process of welding would dispel much of this doubt.

The manufacturer of a certain type of machine, which is built entirely of welded steel, recently stated that they were very careful to eliminate all evidence of welding. No reference to the machine's being welded is made in any of their advertisements or other printed matter. This is done because of the sales resistance to welding they have experienced in marketing their product. The machine is not sold to the general public, or this procedure would be unnecessary. It is sold to engineers and production managers who, above everyone else, should know about welding and have faith in it when properly used.

It was very noticeable at the recent machine tool show that manufacturers who used welded construction took pains to cover it up just as much as possible. This was not solely for the sake of appearance, although it is admitted that a smooth well-rounded fillet has a very definite appearance value. A gentleman who was much interested in the subject at the time called attention to the fact that regardless of all the publicity on welded construction, he saw none of it at the show. Fortunately, it was possible to give him the names of about twenty well-known machine tool manufacturers who were exhibiting welded structures there, but unless one was looking for this feature particularly, it was difficult to discover many examples of it.



Symbol of Weld is Y

This weld to be used only when pieces are joined at right angles and stress is parallel to weld.

PLATE THICKNESS "A" IN INCHES	ROD SIZE INCHES		WT. OF WELD PER INCH POUNDS	C INCHES	B INCHES
1/4	3/16		USE	WELD 1-P	
3/8	3/16		.02	1/8	1/2
1/2	3/16		.035	1/8	1/2
3/4	3/16	1/4	.065	1/8	5/8
1	3/16	1/4	.088	1/8	5/8
1 1/2	3/16	5/16	.13	1/8	5/8
2	3/16	5/16	.21	1/8	3/4
2 1/2	3/16	5/16	.26	1/8	3/4
3	3/16	5/16	.42	1/8	1
3 1/2	3/16	5/16	.50	1/8	1
4	3/16	5/16	.55	1/8	1

Standards sheets for welded design considerably simplify the detailed application of welding

Now the reason that sales resistance to welded construction exists among many engineers is that they have not employed it to a sufficient extent to become acquainted with its various methods of application and the results obtainable thereby. They do not use it in their designs because they have the idea that only a welding technician can design welded structures. This is an erroneous view, especially with respect to the type of structures under discussion, i.e., machinery.

There is nothing mysterious about a weld. It is simply a joint by which two pieces of metal are held rigidly together. Rivets and bolts perform the same function. If the physical qualities of the weld, such as tensile strength, ductility and resistance to fatigue and impact are known, and these fulfill the requirements, the joined pieces may be considered as one piece and the fact that they are welded may be entirely forgotten.

The question is immediately asked, "What if the weld is not perfect?" It does not have to be perfect. Welds generally consist of a number of layers of weld metal superimposed on each other and fused together, and the possibility of slight imperfections in several layers occurring at the same point is very remote. It is no more necessary to examine a weld for blow holes, segregation, and cracks than it is a casting. Nor is it more necessary for a welded joint to be perfect than a riveted one, for conventional factors of safety take care of discrepancies or variations in workmanship and material.

Workmanship Standards Are High

The question as to whether there is a standard of workmanship among welding operators which may be depended upon may be answered positively in the affirmative. This is especially true in the field of machine construction. It is assumed that the designer of such machinery will depend upon a competent welding unit in his own organization, or that the work will be sent to a reputable commercial weldery. In either case, the standard of the work done will be sufficiently high and uniform for his purpose. With modern apparatus and materials, welding of mild steel presents no difficulties and resulting welds are quite satisfactory from every viewpoint.

It is realized that special conditions and materials modify welding procedure and introduce problems which require a specialized knowledge of welding. Some of these involve metallurgy and heat treatment, and must necessarily be left to experts in this line. Expert advice is readily obtainable when such special problems are encountered.

Many detailers design riveted joints with little knowledge of riveting except that given in our standard engineering handbooks. They seem to have learned the difference between a rivet in shear and one in tension without any exhaustive study of the subject. Give them the same data on welded joints, and a general knowledge of the properties of weld metal to be added to their usual good mechanical sense, and they

(*Concluded on Page* 69)

The Versatile Torch

—A Tool for Design

By Allen F. Clark

GAS-WELDING—torch cutting—flame hardening, production tools of great versatility, offer the designer the opportunity of arranging his machine elements to fit exactly the form desired, the requirements of stress and the need for hardness, without waste of material, high cost or undue difficulty. Further, these processes make it possible to change the design of details or of whole mechanisms whenever desired to suit individual buyer preference without increasing to any extent the cost or difficulty of manufacture.

When designing to use these processes, there are a few points that should be carefully watched. Fundamentally, the designer must be cautious to provide against excessive contraction and expansion strains. He must choose basic construction materials which not only take care of necessary strength but will, in many instances, also withstand possible corrosive or abrasive wear as well as maintain these qualifications when high temperatures may constitute a part of the working conditions.

In the choice of raw materials it is essential that preference be given to those which will permit the finished weld to approximate the structure and characteristics of the parent metal under whatever working conditions the final structure may operate. The designing engineer should also be mindful that certain types of welds may or may not need proper heat treatment and, in some cases, may require this when the total structure is of a size or a shape too large or cumbersome for the heat treating machinery readily available.

Welding today is quite different from what it was ten or even fifteen years ago. It has grown from a simple semi-mechanical process of joining or cutting to a matter of applied metallurgy. This change is due largely to the tremendous advances made during recent years in the knowledge of metals. Materials are now made to suit service requirements—a new alloy, if necessary, is developed. The result is that modern oxy-acetylene welding and cutting has been called upon to meet fabrication demands for these new materials. This has made a defi-

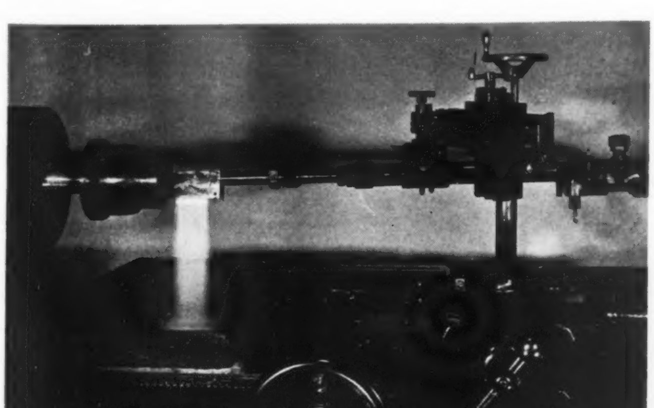


Fig. 1—Left—Water-cooled multiflame tips are employed to harden broad areas. Fig. 2 — Right — A special type of tip is required for the hardening of both sides of gear teeth at one time

nite demand on the energies of research laboratories, engineers and on the help and co-operation of users of the process.

November, 1935, marked the culmination of the first step in making possible a wider use of chromium-iron alloy materials, this step being better fabrication by welding and cutting.

Problems of air-hardening in the 4 to 7 per cent chromium steels were overcome both for welding and cutting of these materials. Air-hardening propensities of the 12 to 30 per cent chromium steels were overcome in a similar fashion. The well known tendency toward intergranular corrosion at high temperature of the 18-8 type steels had become a serious problem up until the middle of 1935 when methods of overcoming these factors were developed.

Similar problems presented themselves in the cutting of these various materials either in cast or plate form. What is of greatest significance is the fact that it was discovered that the use of columbium or titanium in small quantities properly alloyed in these various materials were found to eliminate the air hardening difficulties, to improve ductility even in the as-rolled condition and to improve the cutability of these materials.

This development is one of the most significant in recent years and is one which will merit watching for the future.

Oxy-Acetylene Cutting Progresses

Progress in oxy-acetylene welding has been paralleled by continued developments in oxy-acetylene cutting or flame shaping. The use of torch cutting as a major production operation has been considerably increased in economic value through the development of a variety of machines for operations ranging from the simple beveling of steel plates to the cutting and shaping of complex shapes in three dimensions. For many purposes the cut pieces can be used without further machining or finishing. It must be remembered, however, that no one type of cutting machine possesses sufficient range to take care of all of the various cutting operations required for economical fabrication.

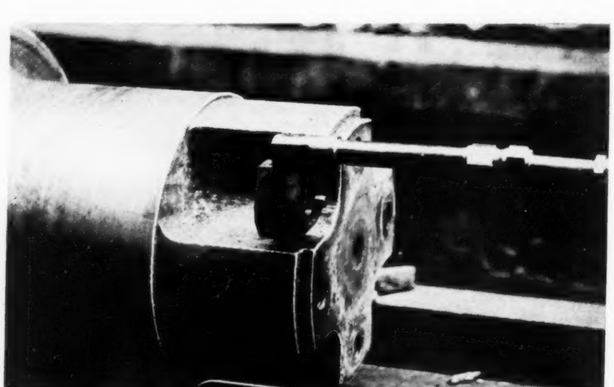


Fig. 3—Hardening with multiflame tips permit treatment of a chosen small area

Recent advances in shape cutting machines consist especially of improvements in the various operating features, devices and controls intended to make the operation of the machine as a whole, as well as the drive, the torch and its gas supply, and the moving parts of the machine, simpler and more efficient. The possibility of vibration affecting the suspension members and the torch has been eliminated as far as possible. The use of various fuel gases other than acetylene, such as natural gas, etc., has increased in localities where they are easily and economically obtainable. Such fuels have been made practical by the development of a cutting torch especially adapted for natural gas and oxygen.

More Extensive Designs Possible

In regard to the design of machine parts produced by shape cutting, it may be said that both much simplified as well as more extensive and complicated designs are made possible by this process. In addition to its ability to form intricate shapes, such as those shown in *Fig.* 4, torch cutting enables the designer to overcome the most pertinent criticism advanced against welding, the too frequent lack of pleasing contour as judged by conventional steel and cast iron equivalents. An example of how this problem has been solved can be found in the large sections shown in *Fig.* 5 which possess the smoothness and grace of form generally associated with good machine construction.

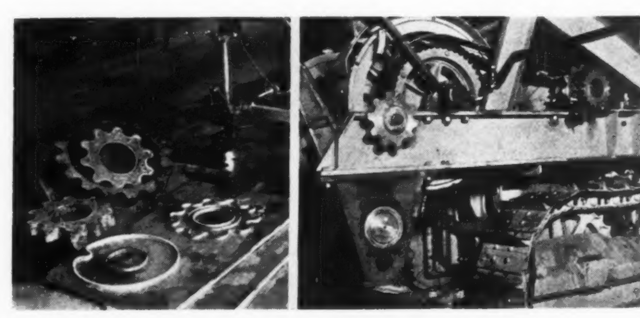


Fig. 4—Intricate shapes such as these can be cut with the torch and applied directly in the machine

While the making of three dimensional cuts is not a new application by any means, having been practiced from time to time for several years, its recent wider acceptance is important to industry. The fact that a finished product, or a product which requires very little finish machining, can be shaped out of a solid block of steel means an important saving to industry in general.

Another operation that has advanced rapidly is that of stack-flame cutting. More and more shops which have been utilizing the flame shape-

cutting process have come to realize that the economies of the process can be greatly improved by a little closer study of procedures. The answer in many cases has shown itself to be stack-flame cutting in which several layers of plates are stacked together and a multiplicity of similar parts are turned out at the same time by the use of one cutting flame.

Cuts are made today to much closer tolerances than those originally considered safe. This has been made possible by the increased precision of representative shape cutting machines and through increased knowledge of the effects of

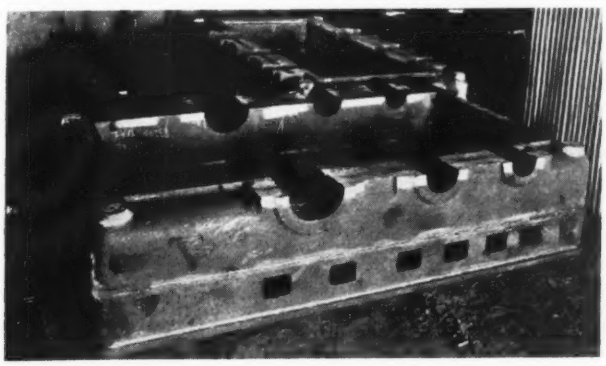


Fig. 5—These bases demonstrate the ability of the cutting torch to facilitate smooth contours

flame cutting. A number of investigations have shown the effects of flame cutting to be both much more limited in extent than at first supposed and also to have usually a beneficial effect on the cut face. Consequently, gas cut faces seldom require more than a light machining operation where other finished surfaces are to be fitted.

Hardening with the Gas Flame

In the same production family with gas welding and torch cutting is the process of flame hardening, the availability of which enables the designer to add important attributes to his machine. For the bulk hardening of small objects which are to be uniformly hardened throughout their mass, furnace hardening is undoubtedly cheaper than hardening with the oxy-acetylene process. However, there are a number of hardening operations where the pieces to be hardened are of considerable size and where distortion of the hardened piece when furnace heated cannot be prevented. Numerous applications require hardening of only a small portion of the total surface. To list all of the various applications would involve the entire machine building industry since wherever the selective wear of a machine part is present, there is a possible application of flame hardening.

In approaching a flame-hardening problem, the first point to bear in mind is the suitability of the steel for hardening. It is quite possible

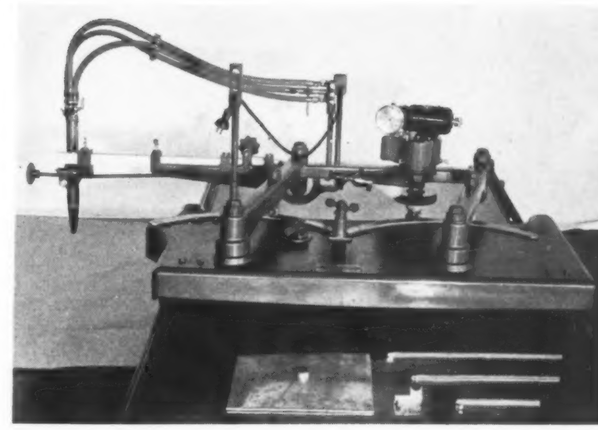


Fig. 6—Improved automatic cutting machines have smooth, vibrationless operation

that the steel composition is such that satisfactory hardening cannot be obtained. In many cases, however, it is possible for the designer to adjust the analysis of his machine part to make flame-hardening possible. The part having been considered suitable for a flame-hardening operation, it is possible that the standard two-flame heating tip, either hand or machine guided, can be used, quenching being done with a suitable medium, water or compressed air.

Multiflame Tips Are Developed

Applications involving the heating of a broader area have required the development of water-cooled multiflame tips consisting of a solid brass or copper block containing a number of fine holes as heating orifices. These tips are generally provided with a row of quenching holes following the heating holes, passing either water or compressed air for the quenching stream. In *Fig.* 1 two rows of eleven heating flames are visible against a background of the water curtain issuing from quenching holes.

Fig. 3 illustrates the use of the flame-hardening torch and multiflame tips for hardening steel wabblers of steel mill rolls. Gear hardening tips positioned over a gear tooth are shown in *Fig* 2. Both sides of the tooth are simultaneously treated with consequent reduction in distortional effect.

From these few examples, the value of flame hardening, along with its brother processes—gas welding and torch cutting—is apparent to every designer. The processes are available—it merely remains for the designer to take advantage of the possible flexibility of design which these methods permit.

For their assistance in the preparation of this article, and for the illustrations used, MACHINE DESIGN wishes to thank Air Reduction Sales Co., General Welding & Equipment Co., Harris Calorific Co., Linde Air Products Co., Victor Equipment Co., and Weldit Acetylene Co.

Hard Facing or Solid Metal-Ec

By E. W. P. Smith

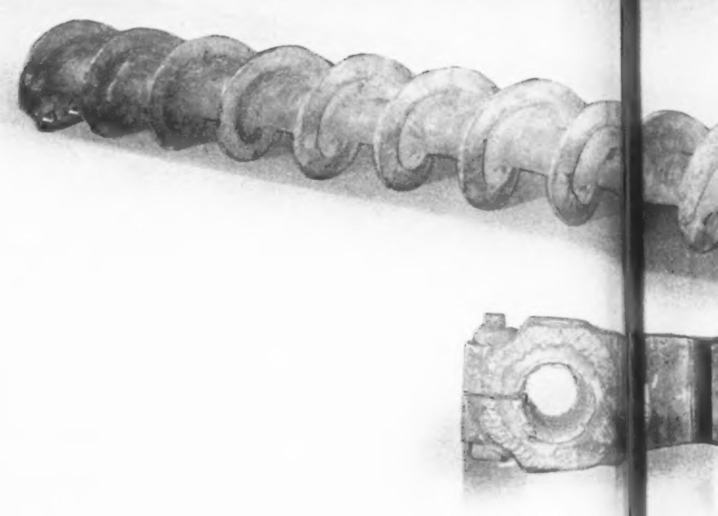


Fig. 1 — Abrasi may ta
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TABLE I

Surface Metal Economically Used With Low-Cost Base Material

Cost Per Pound Single Metal, cents	Cost Per Pound of Surface Metal, Dollars 1.00	2.00	3.00	4.00	5.00
20	15.8%	7.7%	5.1%	3.8%	3.0%
40	37	18	11.9	8.9	7.1
60	58	28.2	18.6	13.9	11.1
80	79	38.5	25.4	19	15.1
100	100	48.7	32.2	24	19.2
120	......	59	39	29.1	23.2
140	......	69.2	45.7	34.2	27.3

Per cent weight of surfacing material is based on total weight. Support metal at 5 cents per pound.

SERVICE life, measured in performance and cost of that performance, must be adequate for every piece of equipment. This adequate performance may be obtained either by making the entire part of a special metal, or by using one metal as a support and another to receive the load. As is well known, the metal that receives the load may be deposited by welding. From the foregoing, it is apparent that this surfacing by welding should be carefully considered from the viewpoint of service life of the equipment, and the use of this process requires a careful study of the economic factors involved.

There are three definite reasons for the use of hard surfacing in the fabrication of various types of equipment. These are: It improves service life; it reduces overall costs; and it lessens operating costs. Service life involves the load conditions to which the parts are subjected; and these conditions may be classified as to rate of application of the loading such as uniform, impact or vibration.

Under impact loading time rate of load application is also important. In considering wear, abrasion is usually regarded as a grinding action as when operating in sand; or a sliding, rubbing, or rolling action, as when one metal moves over another. Corrosion involves gas or atmospheric conditions as well as liquids and, in some cases, the action of solids on the material under consideration. Operating temperatures also affect service life.

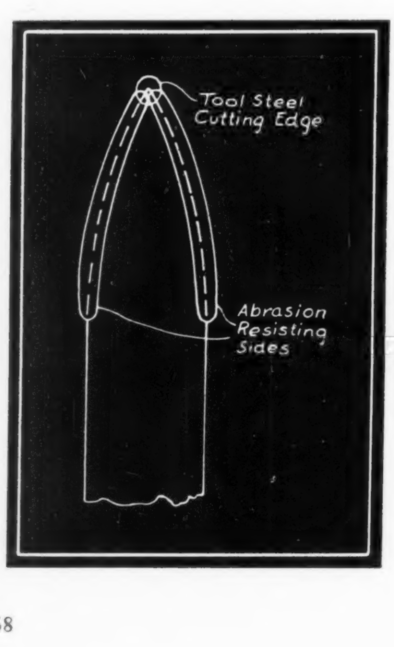


Fig. 2—Cutter for use on fibrous materials employs a tool steel cutting edge while sides have an abrasion resistant surfacing

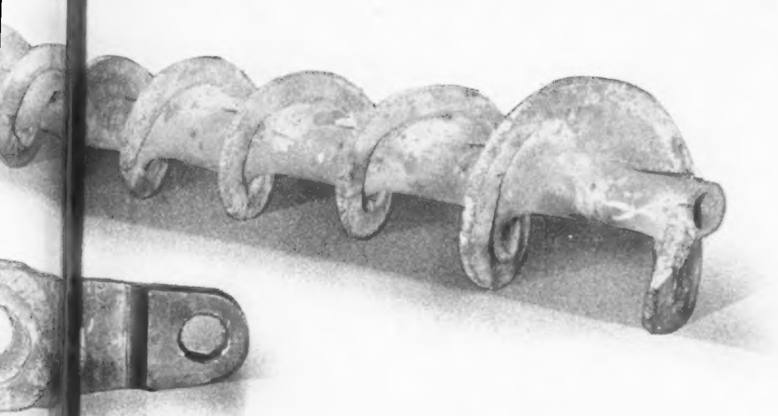
Condition of Surface Metal Important

Insofar as surfaces deposited by arc welding are concerned, another consideration is important. This is the condition of the surfacing metal immediately after it is deposited. The surface either possesses its complete characteristics as deposited, or it must receive some subsequent treatment. For example, one surface may be hard as deposited, while another may require peening to obtain the desired hardness; or, in another case, the surface may require heat treatment after deposition.

Special inserts, chromium plating and electrodes for the deposition of different types of surfaces are available, each having its own characteristics. The electrodes may be grouped according to the ability of their deposits to resist:

IMPACT: Which may be either light

l-Economies Dictate Selection



Abrasi may take many exampl wear on this screw r met to metal contact on ne lin below

THE value of hard surfacing by welding is an established fact. There are numerous alloys available in electrode or rod form which enable the designer to apply exactly the correct material to the surface. All that remains is to determine where and when to make this application. The "where" is easily answered. "When" can be determined from this article, abstracted from a paper to be presented before the American Welding society at Cleveland by Mr. Smith, Lincoln Electric Co.

or heavy in force, or may tend to deform the surface of the metal or cause cracking or chipping.

ABRASION: Which may be either a grinding action due to contact of metal with rock, sand, gravel and similar abrasive materials; or a sliding, rolling or rubbing action of one metal against another.

IMPACT AND ABRASION IN COMBINATION: With one moderate, the other severe, or both moderate or severe.

CORROSION: Including actions of various chemicals, water and also oxidation or scaling at elevated temperatures. May be gaseous or liquid, or gaseous and liquid in combination.

TEMPERATURE: Which may exist in conjunction with each of the above conditions.

Electrodes may be used to obtain surfaces of fairly high carbon steel. The exact hardness depends upon the rate of cooling and, to a lesser degree, upon the carbon content of the supporting metal. On straight carbon steel with natural cooling, hardness may be 20 to 45 Rockwell C. Peening increases hardness, for example, from 33 to 40 Rockwell C; quenching in cold water at 1450 degrees Fahr. increases hardness to 50 Rockwell C.

Where shock and abrasion are factors, deposits may be air-hardening alloy steel. Hardness of the deposits range between 40 and 45 Rockwell C. Depending on carbon content of the supporting metal, the hardness may run as high as 52 to 55 Rockwell C. Parts of equipment subject to sliding abrasive action, batter or repeated pounding and impact may be surfaced effectively with this type of deposit.

Where the surface is subject to sliding action, and the parts must retain their dimensions under high temperature—as, for instance, in metal cutting—a deposit equivalent to high speed tool steel may be obtained. Such deposits, in original condition, will have a hardness of 50 to 55 Rockwell C, provided the deposit is not diluted too much by the supporting metal. Where this dilution is kept to a minimum, as by using two beads, hardness may be as high as 60 to 62 Rockwell C. The surfacing metal retains its characteristic at high temperatures, approximately 1000 degrees Fahr.

Where an abrasive scouring action is encountered with very little, if any, battering or impact, as on agricultural implements, an abrasion resisting alloy, self-hardening, may be used to excellent advantage. Moderate peening increases the hardness from approximately 20 to 30 Rockwell C to approximately 50 Rockwell C. The deposit retains its toughness with maximum hardness at the surface which is cold worked. The deposit may be hot forged.

When the type of deposit required to meet a given service condition is known, the selection of a suitable electrode is readily made.

As an example of the use of surfacing to meet

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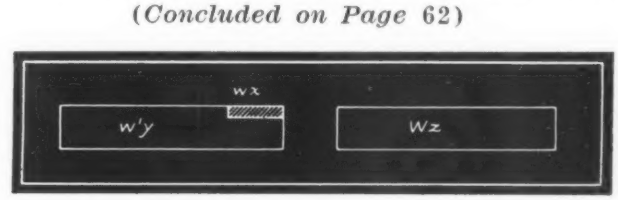
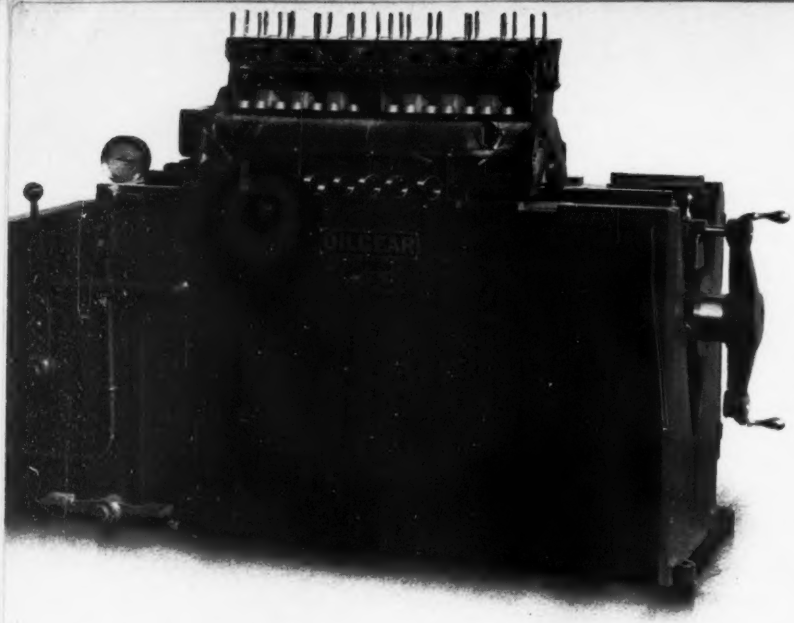
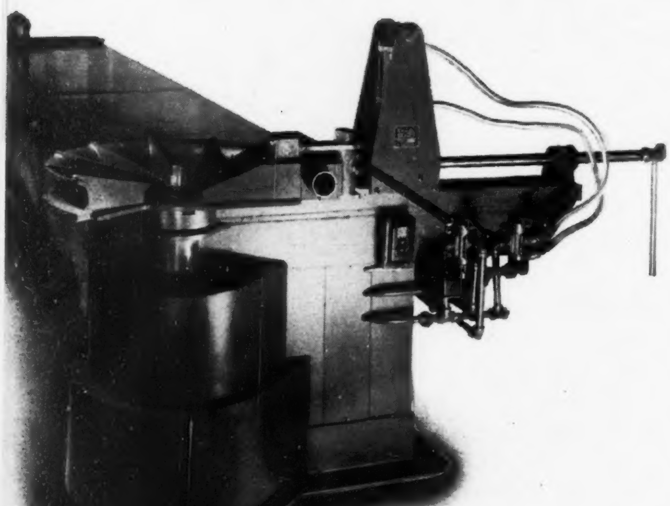


Fig. 3—Schematic representation of cost of single metal and of combination construction



Pump and motor base on Oilgear camshaft bushing assembly press, left, are integral with the press frame which is of all-steel welded construction. Both the horn type pressing bar and the fixture for raising and lowering the block are hydraulically operated.

Improved industrial truck of Baker-Raulang, styled for appearance, has a frame of .40-.50 carbon steel with welded cross members and reinforcements. Convenient hand controls and antifriction bearings contribute to ease and smoothness of operation.



All steel arc welded pipe and tube bending machine, left, is designed to be furnished either hydraulically operated or operated by direct gear-reduced motor drive. This Wallace machine has been developed to permit greatest flexibility in work processed.

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Designed to reduce weight as much as possible to permit the handling of more dirt, the P&H excavator, left, has an all-welded dipper made of rolled steel. Helical gears are used in both reductions of the hoist mechanism. A live roller circle with hook rollers eliminates any pull on the center pin.

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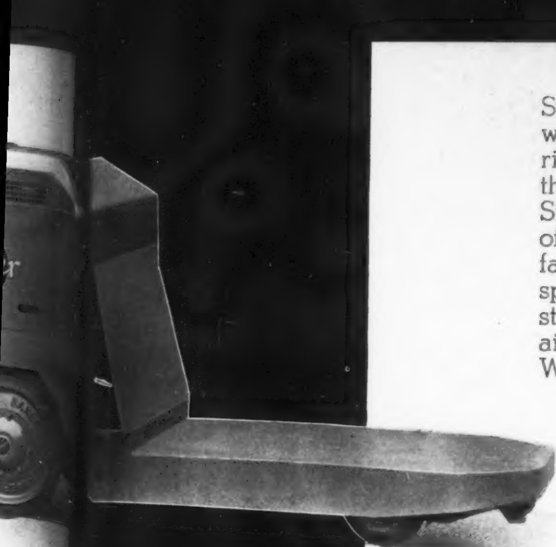
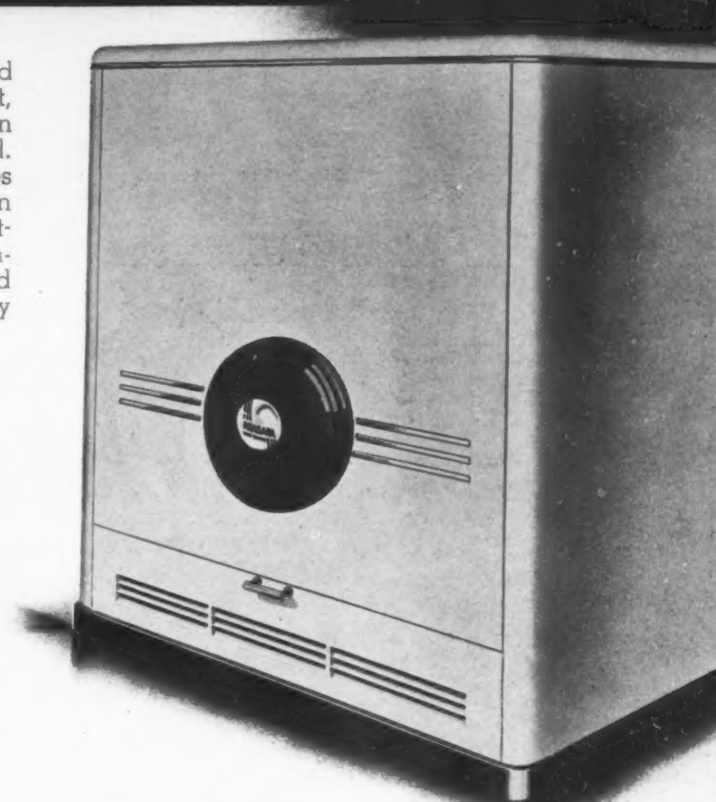
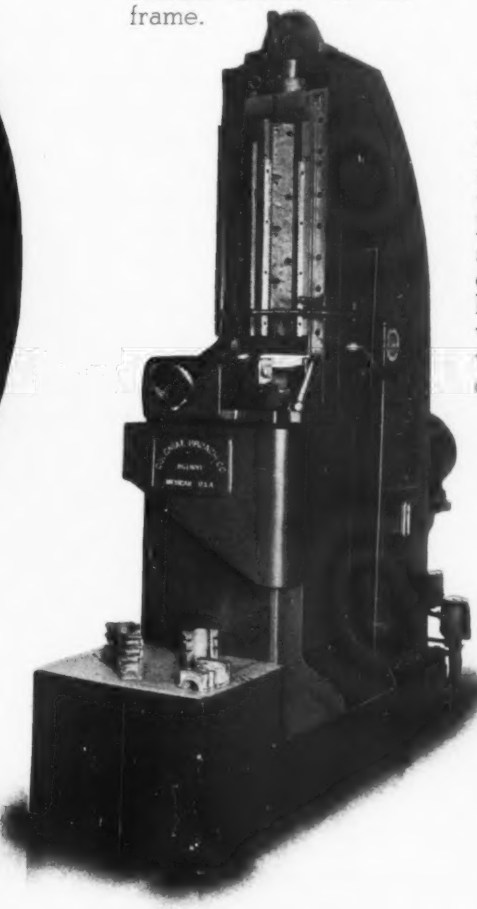


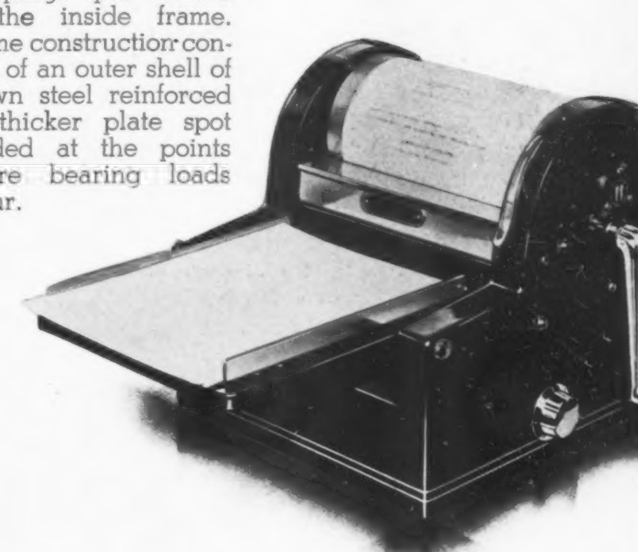
Sub-base of Niagara gas-fired winter air conditioning unit, right, is made from angle iron that has been electrically welded. Side casings are of various gages of sheet metal and angle iron fabricated by spot welding. Eight-speed twin blower insures a constant distribution of evenly warmed air. Styling of the cabinet is by Wilbur Henry Adams.



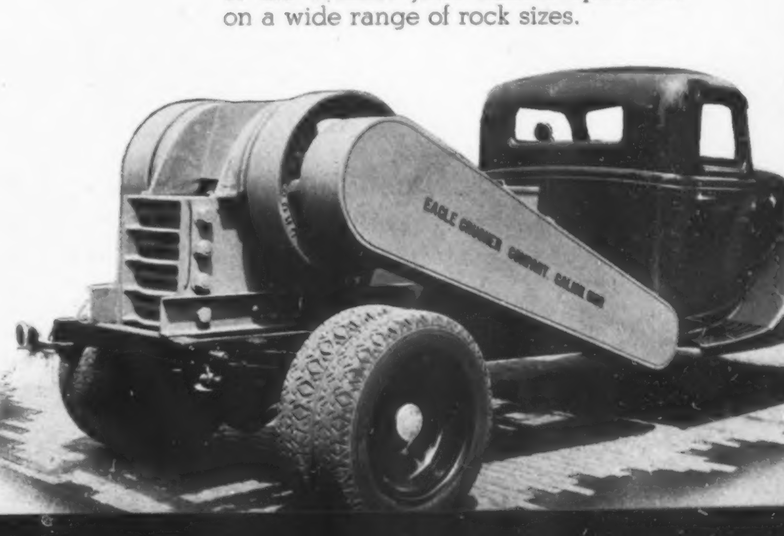
Flame cutting is employed to shape the rolled steel used in the Colonial single ram broaching machine, below. Details of the machine are assembled by arc welding. Operation of the unit is by hydraulic means with pumps and controls included inside of the frame.



Guides for the feed tray of Ditto duplicator, right below, are steel stampings spot welded to the inside frame. Frame construction consists of an outer shell of drawn steel reinforced by thicker plate spot welded at the points where bearing loads occur.



Portable rock crusher is operated from the truck motor by means of a split drive power take-off. This Eagle machine employs welding in its fabrication to insure rigidity. Adjustments of the crusher jaws enable operation on a wide range of rock sizes.



Eighty - eight different stampings go to make up the cabinet of the Kelvinator roll top beverage cooler, left. The entire cabinet is supported from the base made entirely from 16 gage steel, both acetylene gas and spot welding being used in the assembly. Two end superstructures, likewise using gas and spot welding, are elaborate stampings, lanced and formed in a manner to afford strength yet permit free circulation of air.

Economies Dictate Choice of Hard Facing

(Concluded from Page 59)

service conditions, take a certain type of cutter used for cutting rather fibrous material under vegetable acid conditions. The edge must cut, the sides must resist abrasion and all parts must be corrosion resistant. Using a single metal to meet all requirements would obviously result in a compromise. By use of surfacing, however, the edge may be hard tool steel and the sides an abrasion-resisting surface, as shown in *Fig.* 2.

Surfacing by welding is very economical in a great many instances. Usually the more expensive surfacing metal is placed on a base metal of rather low cost. Therefore, the total cost including surfacing need never exceed the cost of the original single-metal construction.

For example, assume a single metal part of weight W which costs z cents per pounds. A new design is desired, taking advantage of the economy of surfacing. We will assume that the proper surfacing material has been selected. The new part is made of base metal of weight w' costing y cents per pound and surfacing metal w costing x cents per pound. The problem becomes one of calculating the maximum permissible amount of surfacing that can be used.

The maximum permissible cost of the new design, assuming that the old design is efficient, and that it is not necessary to increase the size of the part, is the cost of the single-metal construction. In other words, the cost of the less expensive metal plus the higher cost surfacing metal, $xw + yw'$, must not exceed the original cost, Wz, *Fig.* 3. This gives us

$$xw + yw' = xW \quad \text{.......... (1)}$$

We know that

$$W = w + w' \quad \text{.......... (2)}$$

Assuming that (1) is an exact equation, substituting (2) and reducing, we have

$$\left(\frac{x-z}{z-y}\right) \times w = w' \quad \text{.......... (3)}$$

Adding w to both sides of equation (3) gives

$$\left(\frac{x-z}{z-y}\right) \times w + w = w' + w = W$$

Or

$$\left(\frac{x-z}{z-y}\right) \times w = W$$

Without resorting to the numerical value of the weights, this equation gives us, knowing the prices of the metals, the per cent of the total weight, W, which can be surfaced at varying prices without the cost of the combined metals exceeding the cost of the original construction.

As an example, the maximum per cent of surface metal at \$2.00 (x) per pound which can be used with a base metal at 5 cents (y) per pound without exceeding the cost of the single-metal construction at 80 cents (z) per pound is:

$$\left(\frac{200-5}{80-5}\right) w = W$$

$$w = (75/195)\,W$$

$$w = 0.385\ W$$

This calculation shows that the surface material may be as high as 38.5 per cent of the total weight without exceeding the original cost. This clearly indicates the possibility of cost reduction, as 38.5 per cent is an extremely high percentage for the amount of surfacing on any part. It is obvious that any reduction in the weight of this surface metal is very profitable.

Based on the total weight of a given part, the per cent weight of surfacing material which may be used without exceeding the original cost with base metal at 5 cents per pound is given in TABLE I.

This table indicates that for a surface material as high in cost as \$5.00 per pound against an original cost of 20 cents per pound, 3 per cent may be surfaced by welding and the original cost not exceeded. More usually it will be found that 20 per cent or more may be surface metal without increasing the original cost. This in-

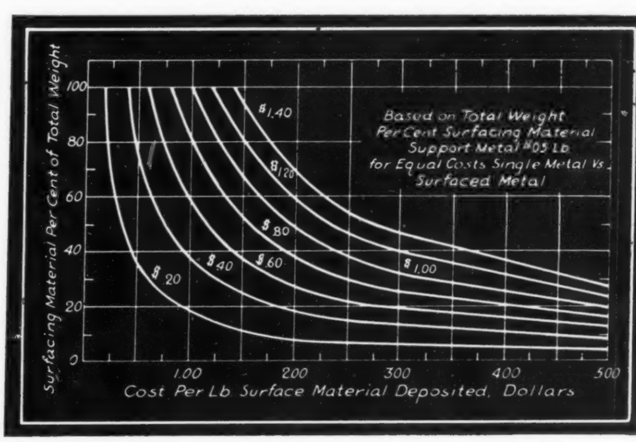


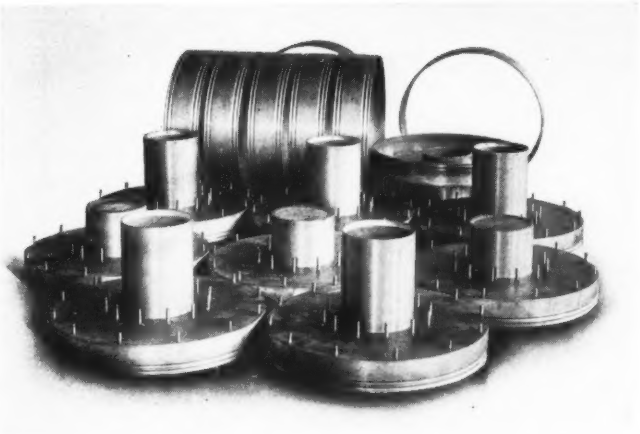
Fig. 4—Percentages of surfaces which may be covered economically are indicated by this chart

dicates the great cost reduction possible by using high grade metal on cheaper base metal.

Percentages of metals which may be surfaced are also shown in curve form in *Fig.* 4.

It should be noted that too much or too deep surfacing may be undesirable. Not only is it costly, but it may be found that the metal may not be as satisfactory as when deposited in fewer layers. Proper design, utilizing hard facing, required just the proper amount of surfacing material—an amount readily determinable by the experienced designer.

Send It Out for Welding?



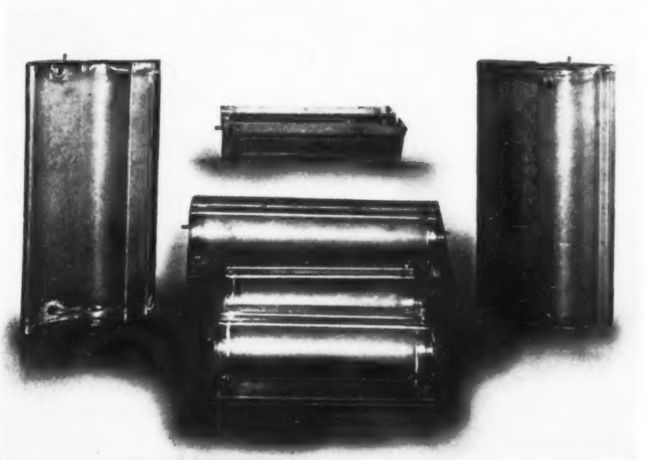


Fig. 1—Top—Light, neat appearing parts such as these can be obtained by built-up welded construction. Fig. 2—Bottom—Ink tank requires the use of a special alloy of corrosion resisting properties

THE CONSIDERATION of welding involves many factors outside of the mere determination of stresses. One of these factors, and a most important one, is the question of equipment and personnel needed to produce the welds. Every designer knows the difficulties involved in laying out his designs for production in an inadequately-equipped shop. We present herewith the case for the weldery as brought out by Mr. Spooner of Spooner & Kriegel, industrial consultants. Photographs and data courtesy L. O. Koven & Bros. Inc.

By William B. Spooner Jr.

THERE was a time when a company pointed with pride to the fact that every part of its machine was produced under one roof. In the days before mass production this situation was not simply a matter of pride, quality of product usually depended on the ability of management to watch each individual stage of operation for even the smallest, most standardized part. In those days there was every reason for "making it yourself."

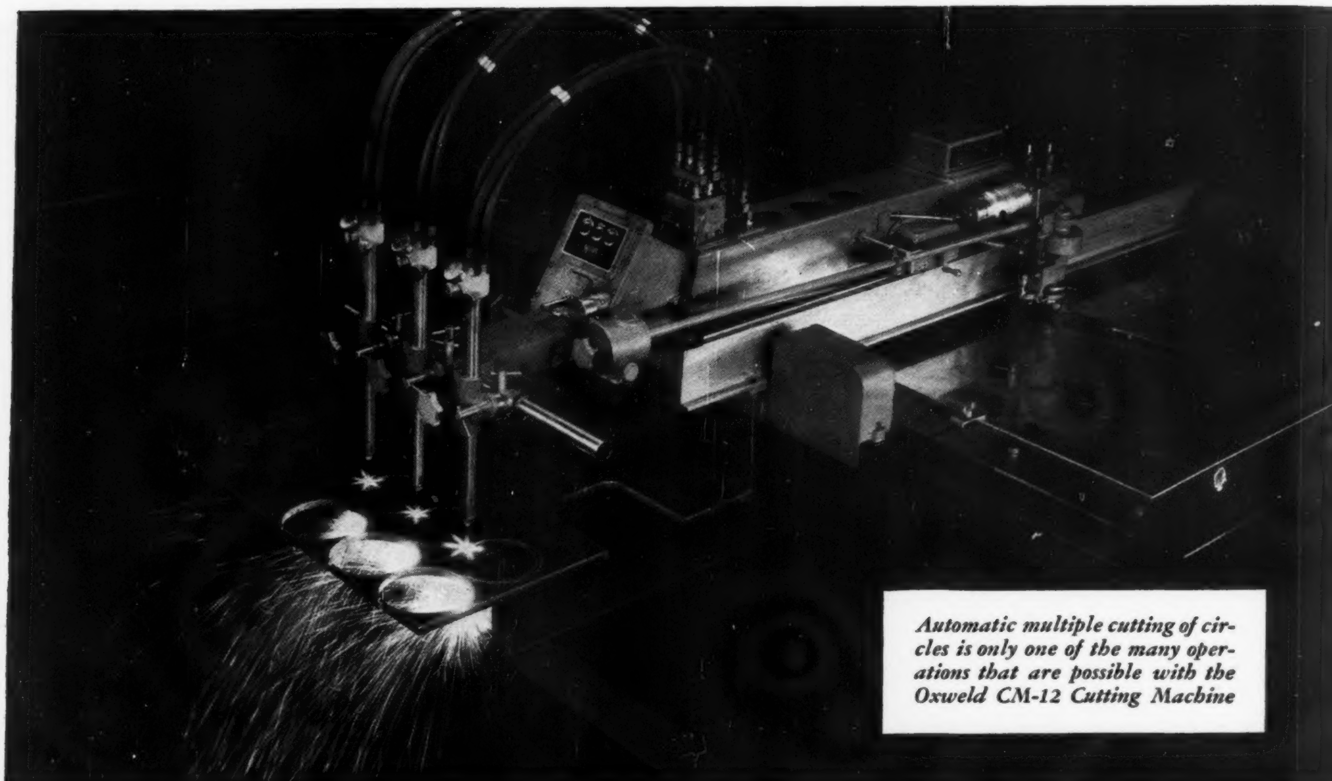
If conditions had not changed, today's industrial picture would be far different from what it is. We would have a great number of plants making their own electric motors, switches, starters, and the innumerable other items of accessory equipment used on machines. As it is, you will find very few firms making their own motors, or even pumps, no matter how specific the requirements may be for out-of-the-ordinary characteristics.

Common Sense Practice Applies

Such common sense practice has already led to a large volume of equipment being made by outside organizations, and brings us to the question as to whether a much more extensive use of this principle is not possible. There is no intention of suggesting extreme dependence on the outside company. There will always be phases of the manufacture of all equipment which deserve that close supervision obtainable only in your own plant. Nor is this idea of less "rolling of your own" intended to apply primarily to the small organization unable or unwilling to set up its own manufacturing facilities. Such companies are obviously dependent on others, and readily entrust their entire production problem, from finished drawings to final assembly, to some other company.

There are, however, any number of additional cases where it will be profitable, both from the viewpoint of costs and of quality, to turn over to some other organization the production of some parts of a machine.

A broad field is brought into existence by improved methods of construction. The adoption of these admittedly better methods may entail



Automatic multiple cutting of circles is only one of the many operations that are possible with the Oxweld CM-12 Cutting Machine

Metal Working *goes Modern with Oxy-Acetylene Machine Cutting*

MODERN metal working demands a fast, flexible, accurate, and economical method for shaping metal parts. Oxy-acetylene shape cutting with new automatic machines developed by Linde is the answer.

For every cutting need, there is an Oxweld cutting machine... portable or stationary, partly or fully automatic, and of almost any desired capacity. These machines are precision production tools that cut intricate shapes with amazing accuracy.

The Oxweld CM-12 Cutting Machine illustrated is Linde's latest contribution to automatic precision shape cutting. Such features as rigid crane-type construction . . . ready adaptability to hand tracing, templet tracing and radius cutting . . . unusual flexibility for automatic straight line, circle, bevel, and angle cutting . . . and fully automatic dual controls make this an ideal all-purpose machine.

The experience accumulated by Linde through pioneering the oxy-acetylene process and servicing the welding and cutting needs of over 100,000 users of Linde products is available to you. Ask a Linde representative to call. He will help you determine what oxy-acetylene machine cutting can do in your plant and which machine is best for your purpose. Address the Linde office near you. The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, New York and principal cities.

Your Opportunity

See the Oxweld CM-12 Cutting Machine in operation at the Linde exhibit, Booth 0-30, National Metal Exposition, Public Auditorium, Cleveland, Ohio, October 19-23, 1936.

Everything for Oxy-Acetylene Welding and Cutting

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extensive investment in new equipment for your plant; long and costly training of personnel; much rearrangement of plant operations and probably a great deal of expensive "bug chasing." Then there is the related situation, met with quite frequently in these days, where a firm takes on a new group of products, the manufacture of which does not fit into existing plant practice, or facilities. Or certain special alloys, such as stainless steel, silicon bronze, monel metal, etc., or such metals as aluminum, copper and nickel may be indicating promising possibilities. Unless a manufacturer is thoroughly experienced in the use of such metals and is properly equipped to handle them, it will usually be found to be definitely advantageous to let experienced fabricators do the work.

A fertile field for this whole idea of letting someone else "roll yours" is that of metal carpentry, generally known as built-up welded construction. This method, depending on ingenuity, ample facilities, trained personnel and sound engineering for its success, has enabled many a firm to produce better looking, stronger, more serviceable equipment at lower costs than by former methods.

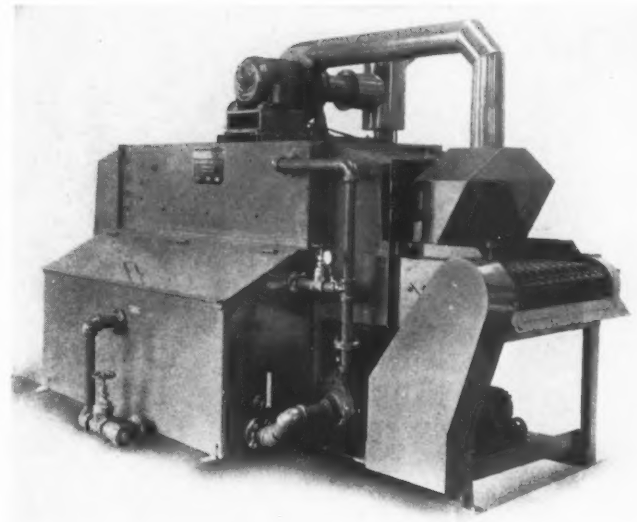


Fig. 3—As each individual unit of these machines varies, welding is widely employed

Fig. 4—Special contours on these tanks requires attention of trained workmen

Specialized Engineering Required

The average plant cannot afford to set up the equipment and trained organization necessary to employ the full advantages of built-up welded construction. It is not only a question of equipment and personnel, but rather of specialized engineering and a special brand of ingenuity. Again, the properly equipped outside organization deserves consideration and in most cases will get the business on the basis of better results at lower costs.

The group of parts shown in *Fig.* 1 are for an ice flaking machine. Made by the method of built-up welded construction, light, neat appearing parts have resulted. These parts, moreover, have ample strength where strength is needed, and utilize in addition the corrosion resisting properties of stainless steel for the cylinders.

The company marketing this machine has a large, well equipped plant, but one which is not suited to the production of built-up welding work. Hence they wisely turned the building of this machine over to an organization properly equipped and experienced along these lines.

Fig. 2 illustrates a rather simple case insofar as construction is concerned. This metal form is used as an ink tank on a special type of printing press. One might assume that the maker of this press would find the work of forming these tanks quite economical in his own plant. But the tanks are being made regularly by an outside concern.

The chief reason for this is that the composition of the inks used in the printing press calls for the use of a special alloy of definite corrosion resisting properties. The one feasible means of getting what was needed was to employ welding for the silicon bronze alloy called for by the inks used. And the outside organization, equipped by experience with this alloy and with ample production facilities, is turning out these tanks at a cost far below that the press manufacturer would face.

The welded galvanized steel transformation elbow illustrated in *Fig.* 5 is used in an air conditioning system. The plant applying this has a well laid out sheet metal shop, constantly busy on duct work for such installations. But in this field there is a virtually steady call for duct fittings of similar complexity to the one shown. All such work is farmed out to another company better equipped to handle the fabrication and welding involved and, in addition, with facilities for hot dip galvanizing. Ordinary duct work is fabricated from galvanized sheet. These complete fittings are hot dip galvanized after welding.

There is good reason for this practice. The tricky nature of the bends and twists called for would only tend to obstruct a smooth flow of production of regular work. Special familiarity

(Concluded on Page 69)


now-LINCOLN'S GREATEST DEVELOPMENT
JOB SELECTOR—
A continuous adjustment which gives any type of arc to suit the job.
CURRENT CONTROL—
A continuous adjustment which varies the arc intensity to suit the job.
TUNE-IN ANY TYPE and SIZE OF ARC-SIMPLE AS A RADIO

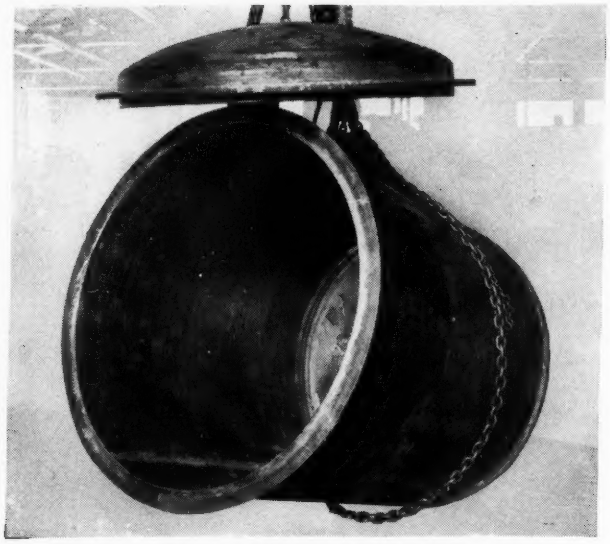
STRENGTH PLUS CORROSION RESISTANCE

DOES NOT EXCLUDE

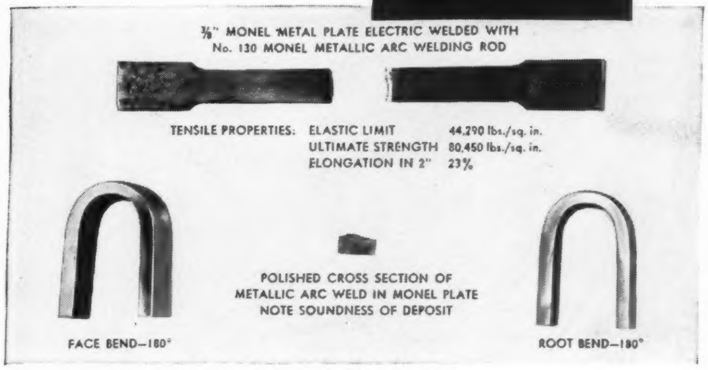
EASE of FABRICATION

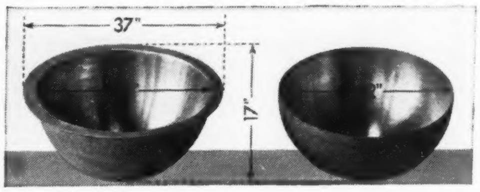
• *TINY THERMOMETER BULBS—Deep-drawn tubular parts of Monel Metal. Thermometer Bulb at right deep-drawn in seven operations with three anneals. Siphon tube at left required ten draws with four anneals.*

• *Below: Excellent mechanical properties in Monel Metal welds.*



• *HEAVY ARC WELDED PRESSURE KETTLE. Welded from 5/16" Monel Metal sheet, this kettle is to be used by Ford Motor Co., Dearborn, Mich., to handle plastics. For a kettle this size to hold heavy weight takes STRENGTH. And the makers, International Conveyor and Washer Corp., of Detroit, chose it for its CORROSION RESISTANCE and lack of harmful effect on the product handled.*





• *BIG BOWLS—32" dia. Seamless Shells 17" deep. These Monel Metal shells for steam jacketed kettles were deep-drawn from .125" thick Monel Metal sheet.*

... MONEL METAL and NICKEL have ALL THREE!

Next time you walk through your own shops . . . just check up on all the ways steel is fabricated to form your equipment. You'll see some men machining, some stamping, others cold-forming and drawing, and some who are brazing and welding.

Remember, *every process you see can be applied to Monel Metal and Nickel.* And *is* being applied, every day of the year.

Take cold-forming and deep-drawing, for instance. The tubular thermometer parts and the large seamless shells illustrated on this page are typical of hundreds of pieces of equipment made by cold-forming and deep-drawing.

And as for welding, both Monel Metal and Nickel can be welded readily by any of the methods used for steel, including oxy-acetylene, metallic and carbon arc, flash, butt, spot and seam welding, silver soldering and brazing. There are slight differences in details from the procedure followed for welding steel, it is true. But your workmen pick these up readily.

For instance: in oxy-acetylene welding, it is best to use a tip one size larger than for steel. And in metallic arc welding, reversed polarity (work negative, electrode positive) is recommended.

One very definite advantage of welding these metals is that the welds require no heat treatment. And the welds, like the parent metal, are inherently resistant to corrosion; and this resistance is not affected by heat treatment.

Send for our booklet, "Welding of Monel Metal and Nickel," and for "Welding Shop Cards," for complete instructions. Ask the Inco welding service for advice on your specific problems.

INCO WELDING RODS and FLUXES

for PURE NICKEL

Oxy-Acetylene . . . No. 41 Nickel Gas Welding Wire.
Metallic Arc . . . No. 31 INCO Nickel Metallic Arc Welding Wire.
Carbon Arc . . . No. 21 INCO Nickel Carbon Arc Welding Wire.

for MONEL METAL

Oxy-Acetylene . . . No. 40 Monel Gas Welding Wire. For flux see * at right.
Oxy-Acetylene . . . No. 43 Silicon Monel Gas Welding Wire. (For Sulphuric Acid Service.)
Metallic Arc . . . No. 130 INCO Monel Metal Arc Welding Wire.
Carbon Arc . . . No. 20 INCO Monel Carbon Arc Welding Wire.

for INCONEL

Oxy-Acetylene . . . No. 42 Inconel Gas Welding Wire. For flux see ** at right.
Metallic Arc . . . No. 32 Inconel Metallic Arc Welding Wire.

for NICKEL-CLAD STEEL (for welding of Nickel side)

Oxy-Acetylene . . . No. 41 Nickel Gas Welding Wire.
Metallic Arc . . . No. 35 INCO Nickel Metallic Arc Welding Wire.
Carbon Arc . . . No. 21 INCO Nickel Carbon Arc Welding Wire.

•

FLUXES

* INCO Gas Welding and Brazing Flux for Monel Metal.
** "CROMALLOY" Gas Welding Flux is recommended for Inconel.
No flux is used for the gas welding of Pure Nickel or Nickel-Clad Steel.

•

INCO welding materials as listed can most conveniently be obtained through regular INCO distributors.

Monel Metal is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N.Y.

Send it Out for Welding?

(*Concluded from Page* 65)

with the troubles encountered in this work was a desirable factor and the daily operation of a well designed, carefully operated galvanizing tank in the plant of the company to which the work is assigned is also a deciding factor.

Fig. 3 illustrates a metal washing machine.

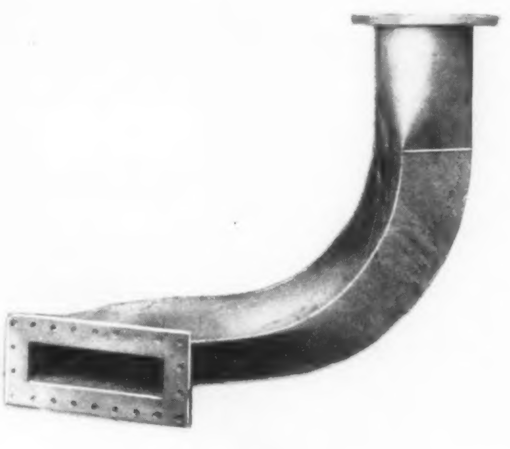


Fig. 5—Tricky nature of bends in this special job might slow regular production

These machines are all based on the same general principles, but each individual unit is designed to meet a specific requirement. The tank may be longer, wider or deeper. The washing zones and the drying zones will be changed from unit to unit, as the work to be done on the articles to be washed may demand. As a result, the maker is really dealing with a special machine each time he makes one.

Formerly, this company made the entire machine, with the exception of motors and drives and some tanks. Today, except for motors and drives, an outside organization makes the entire machine. The maker supplies the design and then assembles the completed parts of the machine as delivered to him by the organization in question. Thus he can concentrate a smaller number of highly trained men on the job of assembling, testing and conditioning his machine for installation, while at the same time he gets far better workmanship and finish than he used to get when he undertook complete production himself.

Fig. 4 illustrates another type of ink tank, used by a different printing press manufacturer. These tanks are for colored rotogravure inks, which must be kept hot. The press manufacturer could have set up facilities to form and weld these tanks. But the special rounded corner design, quick opening covers, piping and fittings would have given him considerable trouble and added expense in adequately training personnel for the work. He made no mistake in picking an outside organization well equipped as to welding and metal working facilities, and with a trained personnel.

It is not possible to set down a list of the things it will not pay you to make yourself. The question must remain open because of the very nature of the problems involved. It seems safe to say, however, that where you require parts, simple or complicated, which necessitate new equipment or unfamiliar operations, you should look about first for some other organization suitably equipped and adequately experienced before you tackle the work yourself.

Rolled Steel–Basic in Welding!

(*Concluded from Page* 54)

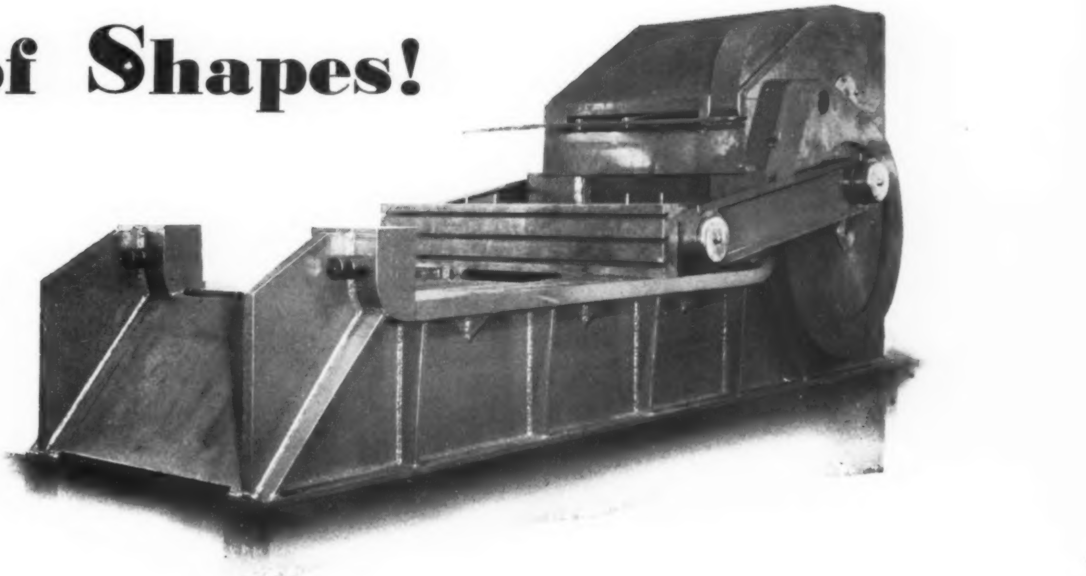
will design welded structures in a very acceptable manner. How disastrous it would be if drawings of riveted structures were sent to the shop marked "rivet here" and nature was left to take its course. For a while this was and still is the accepted method of "detailing" welds in some shops.

It is an exploded theory that a welding technician is required in the design of welded machinery. With standardized data on welds comparable to that available on riveting, a designer of presses who has spent years in that line will design a better welded press than the best welding technician in the world. In the Pittsburgh district there are several hundred men turning out creditable designs without a first-hand knowledge of the technical details of welding.

The way to break down the existing sales resistance to welded construction is to start the thousands of designers in this country using it. The way to start them using it is to give them simple and reliable data on welds. This is a challenge to all who are interested in the more widespread application of the method, and every proper means should be used to place the necessary information in the hands of those who can make effective use of it.

The designer, although unheralded and unsung, is of utmost importance to the development of industry. He does not have time to become a welding technician, nor is it necessary. Supply him with reliable and workable data, and with his keen insight and ingenuity he will quickly grasp the principles of welding and lift welded machine design to new heights. It is with utter sincerity that tribute is paid this man behind the scenes—The Machine Designer.

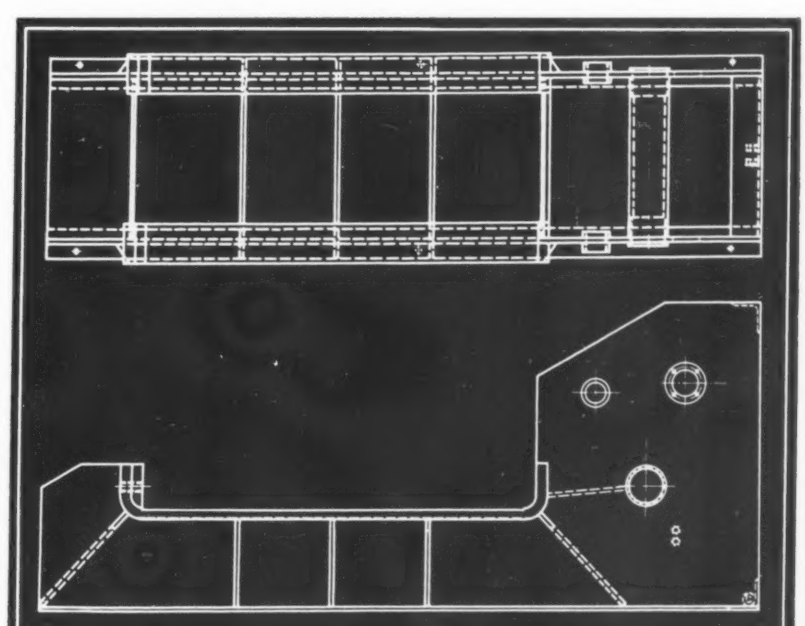
Let Design Govern Choice of Shapes!



By William G. Wehr

Fig. 1—Above—Regular rolled steel plates, flame cut to shape, make up the frame of this bulldozer. Fig. 2—Below—Schematic drawing of web shows arrangement of stiffeners

FAR TOO many designs of machines to be fabricated by welding are dominated literally and completely by the commercial rolled shapes available. By this, we do not mean that these shapes cannot be of value to the design, rather, the reverse is true. But, the design should lead to the selection of shapes; the shapes should not control the design. When they do control, the resulting machine is liable to be heterogeneous grouping of discordant shapes, rather than the result of a carefully thought out design plan. Quite often, rolled plate, formed to the proper shape, is one of the most advantageous materials which can be used to produce a machine which is thoroughly modern in its concepts of well-ordered appearance with efficient operation.



An example of a machine which has passed through the "miscellaneous shapes" stage and progressed to modern principles is the Steelweld bulldozer of *Fig.* 1. This machine, as built today by Cleveland Crane & Engineering Co., is fabricated by arc welding from a few shapes and varying thicknesses of rolled plate, much of the plate being formed to give the desired contours.

As a basis for the discussion of this welded design, let us briefly go over the principle of operation of the machine. Power supplied by a high slip motor built into the frame, is transmitted through V-belts to a gear reduction and to the large drive gear which can be seen on the side of the machine. A connecting rod mounted eccentrically on the drive gear, actuates the tools and thus performs the work. A disk plate clutch is used to govern the intervals of operation.

The pinions in the drive, all of which are mounted on tapered roller bearings, are cut from

Better because THEY'RE *Stainless Steel*

THROUGHOUT industry, thousands of products are *better because they're stainless steel.* Stainless steel is strong and tough. It does not rust and resists the attack of many corrosive chemicals even at high temperatures. Thus, use of stainless steel reduces weight, minimizes wear and corrosion, lowers maintenance, and adds years of useful, trouble-free life. You should investigate stainless steel for your equipment or product.

Electromet does not make stainless steel, but supplies the ferro-alloys that go into its making. For over 30 years, Electromet has cooperated with the steel industry in developing new alloy steels and irons and applying them to the requirements of modern industry. Backed by this experience, Electromet can give you unbiased help in applying stainless steel to your equipment or product. This service is available without obligation.

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steel forgings, while the large drive gear is fabricated by welding. This gear is made up from a rolled steel hub, a steel plate disk, and a .50 C steel plate formed to provide the rim. The teeth are cut into this rim.

In addition to the welded gears, there are two other parts of the working mechanism where welding is employed, the tool slide and the connecting rods. The connecting rods are one of the few parts which require any shapes other than rolled plate. They have as their basis standard I-beams. Semi-circles are flame cut in the ends of these beams and rolled steel

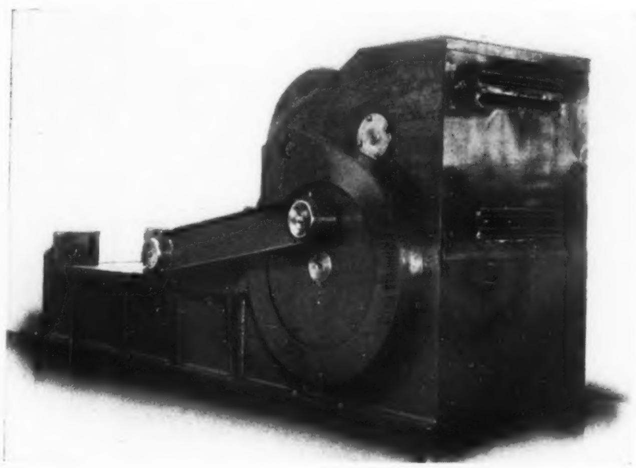


Fig. 3—Welded enclosures over mechanisms enhance the appearance of production machinery

bosses are arc welded in the openings. After this fabrication on the entire rod is machined as a unit.

Welding by the shielded arc is also employed in the enclosure for the operating mechanism, *Fig.* 3. This enclosure was decided upon to further enhance the appearance of the machine, to insure safety, and to keep dirt and dust from the mechanism. It is completely fabricated from rolled plates except in those places where doors are necessary.

The most important element in the design is the base composed of two web plates, way members and connecting parts. At first glance this base might appear to be a complicated structure, but actually it is very simply constructed. The drawing of *Fig.* 2 shows the method of framing a bed for one model of these bulldozers. The side of the machine shown in *Fig.* 1 is one complete plate, flame cut to shape. To the bottom of this member are arc welded narrower plates which, with the way members on the top make this side a built-up I-beam.

The way member on the top of the side plate is again a rolled plate, formed hot to give the arc at the ends. Supporting this way member, and stiffening the side plate, are auxiliary plates flame cut to shape, and placed at the points where design investigation indicated the stress would require further support. The supports shown on the outer side of *Fig.* 1 are duplicated between the two side plates, the members running the complete height of web joining the plates.

In the design, careful consideration was given to the stresses in the way members. It will be noted from the illustrations that these members are not machined close to the formed portion. This was deemed advisable as the curved section is the location of the highest stress concentration in the member. To further strengthen this curved section, supports are arc welded to the web at an angle from the curve, the angle adopted being selected to give the maximum reinforcement. There is also a flame cut section of plate arc welded to the curve at the rear of the way members. This section has a number of functions: It gives greater strength to that portion of the way; it permits a greater thread contact for the four adjusting screws; and it presents a flat surface to the tools and work.

Parallelograming is Overcome

All of the cross plates are designed with another very important factor in mind. Inasmuch as the machines may be subjected to extremely high forces sufficient to cause the mechanism to stall and still must resist breakage, and as the machines may be loaded only on one side, it was necessary to protect against twisting or parallelograming of the frame. With the cross members as shown, this effect is entirely obviated.

Further protection is given the machine by hardened steel plates screwed to the ways where the slide travels. As, in many installations, there is the possibility of scale or chips being caught between this plate and the slide, it was decided in this design to protect against permanent damage that such chips might cause by providing a soft and easily replaceable surface which would take the full force of such scoring. Therefore, an indentation is machined into the bottom of the slide covering almost the entire area of this section. Into this indentation a brass plate is laid. It is not necessary to fasten this plate in place as the weight of the slide will hold it. When it is found advisable to replace the plate, all that is necessary is to cut a plate to the same size and drop it into place.

It can be seen from this presentation that rolled plate has been used wherever possible to give a design of unusual simplicity. Further, the design can be changed within wide limits without the necessity of changing anything but the shop drawing. Such flexibility is well worth while in every machine where small changes must either be neglected or else expensive equipment must be junked. Plates, flame cut to proper contour, can be welded by the shielded arc into strong, simple, reliable machines, yet the design completely dominates the material used and can be changed whenever necessary.

Why Weld?

(*Concluded from Page* 52)

ly desirable. The production involved largely determines which type of base should be used. If high production is required, then castings should be used as the pattern cost can be distributed over a large quantity and the unit cost will be lower.

On the small quantity or an individual machine in the special machinery field, it is advisable to use welded steel construction for the base because of the following advantages: (1) No patterns are required; (2) Less time is required to produce; (3) Cost is less; (4) Extra compartments and facilities for additional operations are easily added; (5) Yearly model changes can be made without scrapping entire machine; (6) Guards can be formed and welded at lower cost, with better appearance; (7) Welded reservoirs eliminate chance of dirt and sand entering compartment; and (8) Maximum strength with minimum weight is assured.

The foregoing are the high spots considered by our engineers when designing new equipment embodying welded bases or other parts.

" . . . . . with chrome-molybdenum."

G. A. Page, Chief Engineer

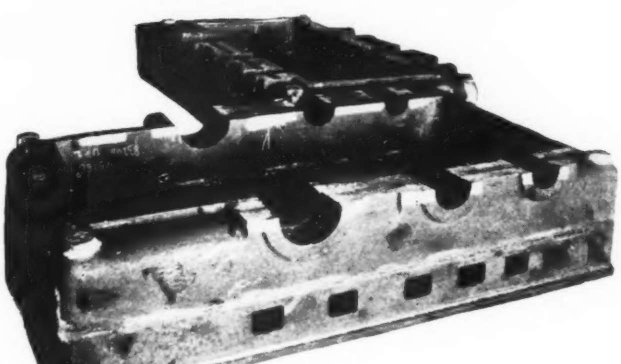
Curtiss-Wright Airplane Co.

IN AIRPLANE construction, oxy-acetylene welding is closely associated with the use of chrome-molybdenum steel tubing and sheet in the fabrication of structural assemblies such as engine mounts, fuselage structures, landing gears, and small parts such as brackets and control horns. Welding is advantageous because of its extreme flexibility in permitting sheets and tubes to be joined at any point and angle.

At the same time, there are several objectionable features to welding: (1) It is difficult to hold close tolerances due to unequal shrinkage of the welded parts; (2) Welded structures have a susceptibility to fatigue cracks which are only partially eliminated by using gusset plates and large factors of safety; (3) In moderate production quantities, welded parts are relatively expensive because welding as we use it is purely a hand operation. Therefore, while we use considerable welding in airplanes, we try to avoid it by the substitution of machined steel and aluminum alloy forgings and castings whenever the production quantity permits.

Fuel tanks and oil tanks for airplanes are generally constructed of sheets of pure aluminum or soft aluminum alloys, gas welded along external joints. The reliability of tanks of this type is satisfactory when concentrated stresses are avoided by making all corners and edges rounded, and when there is suitable support.

Maximum Strength
Freedom in Design
Increased Sales
Extra Profits . . .



The machines used in fabricating the rolling mill parts pictured above: Left—the Airco-DB No. 6 Oxygraph; middle—the Radiagraph; right—Wilson 300 Ampere Arc Welding Machine.

All of these benefits, plus a host of others, are enjoyed by nationally known users of Airco-DB Mechanical Gas Cutting Machines and Wilson Electric Arc Welding Machines.

The wide variety of Airco-DB Gas Cutting Machines permits you to select exactly the type of machine to serve your requirements. Nowhere else will you find such a comprehensive line. And every machine has been thoroughly proved in service as the records of thousands of satisfied users testify.

Sound, economical arc welding to fabricate the gas cut parts into a complete unit is essential. Wilson Electric Arc Welding Machines excel in Arc Stability—the prime essential for low-cost welding with the electric arc. It is the chief factor in determining the speed and quality of the welding and the most important single factor in establishing your direct arc welding costs.

ENGINEERING COOPERATION

AIR REDUCTION, in conjunction with the WILSON WELDER and METALS COMPANY offers the combined cooperation of both organizations for working out specific problems of mechanical gas cutting and electric arc welding. We invite you to avail yourself of this able and experienced service, freely and without hesitation, for it involves no obligation.

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ALL ANALYSES
5/16

Sound Design Will Help Build A Vast New Industry

THOUGH the engineer responsible for design rarely is given credit, particularly by the public at large, for his share in contributing to the wealth and growth of the nation, he certainly plays a major part in pulling it out of business depressions. The classic example of this is the automobile industry in which design is never stagnant and which during the past year or two has done as much as any other to bring us back to normal. Furthermore, it is well known that the highly mechanized industries, all of which necessarily utilize the designer's skill and creations to the fullest extent, are in the forefront in recovering from the low point of three years ago.

Another mechanized field that shows every indication of growing to gigantic proportions, of creating employment and wealth, and of adding materially to the comforts of life, is that of air conditioning. It is estimated that this business during 1936 will reach the $150,000,000 mark and that it is likely to double next year. At that rate we will soon have with us another billion-dollar industry—and a more welcome addition is hard to visualize!

Only one thing could retard this growth—possible shortsightedness on the part of the design profession. The market will only be scratched as long as prices of air conditioning equipment stay at their present level. Consequently it is up to all designers who are or may become identified with this field to put everything they have into the development of sound units utilizing the most economical parts, materials and processes, in order to bring about an industry that soon will rank among the most important in the country.

• • •

On to the Show!

THOUSANDS of engineers are making plans to attend the National Metal Show and Congress in Cleveland during the week of Oct. 19. They and the companies with which they are associated, are to be commended for their forethought.

This year's exposition will be a "recovery" show! Exhibiting companies are spending real money to bring to the attention of machine designers and others the latest in materials and production methods.

Technical papers at the congress also will be indicative of better times to come. From advance copies we have seen, those engineers attending the sessions will be amply repaid for the time and money spent. We hope many MACHINE DESIGN readers will be present—and for those who are, don't forget to look us up, too, if your time permits!

MEN *of* MACHINES

WHEN Secretary Roper called together a number of patent attorneys and business men to study the United States patent system and to recommend improvements, Justin W. Macklin of Cleveland was a member of this committee. For nearly three years he attended monthly meetings regularly, making valuable suggestions on the basis of his twenty years of experience in patent law. This work was followed by his appointment by the President as First Assistant Commissioner of Patents, a post to which he brings practical experience in industry as well as in law.

Prior to studying law, Mr. Macklin worked in a machine shop and later became a machine designer. This early mechanical training proved to be a very effective background to his patent work. He was a wartime officer in the Motor Transport Corps.

JUSTIN W. MACKLIN

• • •

WITH a long record of success in engineering and manufacturing management, John M. Floyd recently joined the A. O. Smith Corp., Milwaukee, as vice president in charge of engineering and production. Mr. Floyd, who has been identified with the automotive industry since the beginning of his career, was for the past nine years an executive with the Bendix Corp., South Bend, Ind. His new duties are to a large degree in the same field. He heads up automobile frame production activities in the Smith plants, as well as the manufacturing of welded pressure vessels and pipe.

Mr. Floyd rose from the ranks. He completed his schooling while serving an apprenticeship and subsequently held positions of foreman, chief draftsman, superintendent and works manager.

JOHN M. FLOYD

• • •

G DONALD SPACKMAN, newly appointed general superintendent of Lukens Steel Co., Coatesville, Pa., is well known for his excellent work in the upbuilding of its subsidiary, Lukenweld, Inc. Mr. Spackman, who was born at Coatesville in 1895, joined the Lukens organization in 1919 shortly after his graduation from Swarthmore College. A year later he was made fuel engineer, in 1925 was appointed superintendent of the flanging department and in 1929 was promoted to be assistant general superintendent. When Lukenweld was organized in May, 1930, Mr. Spackman was elected its president, a position which he has since held.

Achievements of Lukenweld, under the leadership of Mr. Spackman, in the application of welding to the fabrication of frames, gears and other machinery elements are familiar to the

G. DONALD SPACKMAN

readers of Machine Design. The effect of this has been widespread, many companies having entrusted to Lukenweld the engineering and production problems involved in fabrication of machinery by the welding method.

Mr. Spackman is a member of the Union League and Racquet clubs of Philadelphia, of the American Society of Mechanical Engineers and the American Welding Society. In his new duties he succeeds J. H. McElhinney who has resigned after ten years of able service with the Lukens organization in order to become connected with another steel company.

♦ ♦ ♦

Thomas Cruthers has been elected vice president of Worthington Pump & Machinery Corp., Harrison, N. J. Mr. Cruthers, a mechanical engineering graduate from Stevens Institute of Technology, began his career in manufacturing more than thirty years ago as superintendent of gas engine erection in the plant of the Westinghouse Machine Corp.

♦ ♦ ♦

F. A. Bower, former chief engineer of the Buick Motor Car Co., who retired last spring on account of ill health, has recovered sufficiently to undertake a visit to the Adam Opel works in Germany and Vauxhall Motors Ltd. in England as technical advisor to these foreign General Motors associates.

♦ ♦ ♦

Everett Chapman has been elected president of Lukenweld Inc., Coatesville, Pa. Mr. Chapman, who is an authority on arc welding, joined the company in 1930 as director of development and research and has been vice president since 1934. An illustrated biographical sketch of Mr. Chapman was published in Machine Design in April, 1934.

♦ ♦ ♦

Rowland S. Rose has been appointed chief engineer, Wentworth & Irwin Co., Portland, Oreg., manufacturer of bus and truck bodies.

♦ ♦ ♦

Harry G. Cover has been appointed chief draftsman of the construction engineering division, Carnegie-Illinois Steel Corp., Pittsburgh.

♦ ♦ ♦

Dr. Thomas C. Poulter, well known physicist, has been appointed a director of the research foundation, Armour Institute of Technology.

♦ ♦ ♦

G. I. Wright, formerly chief electrical engineer of the Reading Co. and Central Railroad Co. of New Jersey, has been made manager of the transportation department, Westinghouse Electric & Mfg. Co., East Pittsburgh. He will have charge both of engineering and sales of all the company's equipment for the transportation field.

Obituaries

George M. Bartlett, professor of machine design and head of that department at Purdue university, died recently at Indianapolis, following an operation. Professor Bartlett's career was one of wide experience both in industrial and academic work. Following his graduation at Amherst college he was at Case School of Applied Science for a time, then at the University of Michigan for seven years as instructor in mechanical engineering.

In 1910 he joined the Diamond Chain Co., Indianapolis and remained with them for seventeen years, continuing this association as consulting engineer following his Purdue appointment in 1927. Professor Bartlett was active in the affairs of the American Society of Mechanical Engineers and of the American Gear Manufacturers association.

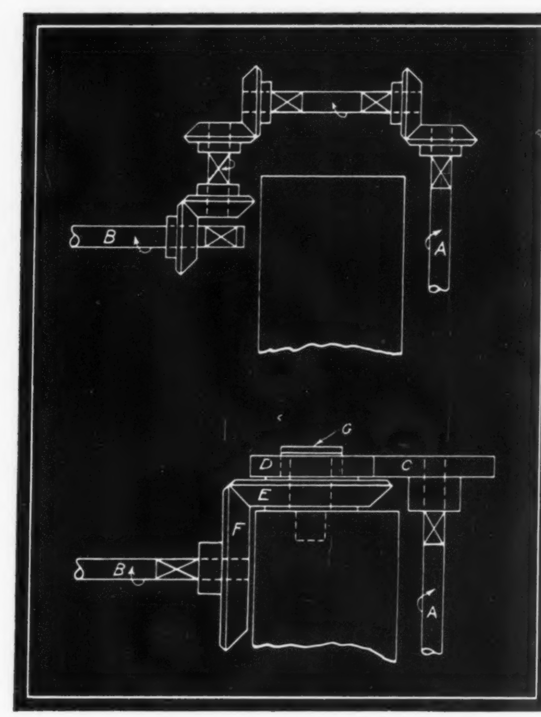
Professional Viewpoints

Simplifying Gear Applications

To the Editor:

AN interesting gear application as used on a wire forming machine is especially indicative of how simplicity may be achieved. The point of interest in the application lies in the fact that a power transmission problem is overcome in a manner which undoubtedly could be given more widespread application, but is usually overlooked.

Referring to the accompanying drawing, shaft B must be driven from shaft A, and at right angles to it. Driving directly through miter gears is impossible due to the position of driven shaft B. The conventional design in this case would consist of three pairs of miter gears with two intermediate shafts, as shown at the top. However, as shown in the bottom view, the same effect is produced in a simpler and more compact manner.



Simplicity is achieved by arrangement of gears which gives compact appearance

Shaft A carries spur gear C at its end, and shaft B carries bevel gear F. Bevel gear E, revolving idle on stud G, meshes with bevel gear

F. Spur gear *D* is keyed to the hub of bevel gear *E*, and meshes with spur gear *C*.

As the pair of spur gears and the pair of bevel gears are of the same ratio, the speed ratio between shafts *A* and *B* is the same as would be produced with the design shown in the upper view.

—L. KASPER,

Philadelphia.

Who Makes Disk Springs?

To the Editor:

ON PAGE 40 of the June, 1936, issue of MACHINE DESIGN you published an article by J. O. Almen on disk springs. Can you tell us the name of a manufacturer who produces these springs as a standard line?

—R. G. DICKENS,

Elmira, N. Y.

To the Editor:

WE ARE glad to inform you that we are familiar with the design and manufacture of disk-type springs, such as those described by J. O. Almen in your June issue. We have been called upon to make quite a number of springs of this type, and can produce them in any stock size which does not exceed 1/8-inch in thickness. The use of this spring has not developed far enough to offer a list of sizes. In fact, each use seems to require a spring that is a little bit different, so that it would be difficult to develop a standardized list of sizes.

—R. G. KISSINGER,

Barnes-Gibson-Raymond Inc.

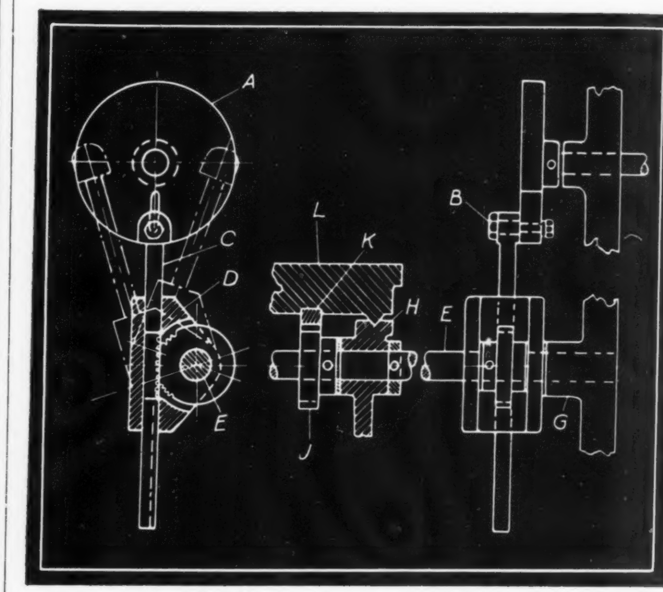
Adjustable Reciprocating Mechanism

To the Editor:

IN A SPECIAL type of plate polishing machine it was found necessary to develop a variable reciprocating mechanism for a table located some two feet from the nearest shaft line in the machine. To obtain such a design, the arrangement shown in the accompanying illustration was adopted.

It consists of slotted disk member *A*, to which is connected by means of adjustable stud *B* a rocking or oscillating rack *C*. This rack is a snug fit in pivoting housing *D*, which housing

pivots about the same center as shaft *E* upon which pinion *F* is fastened. Gear *F* is a sliding fit between housing *D*, thus preventing it from moving endwise. Shaft *E* is supported in a bearing at *G* and also at *H*. The other bearing for rack gear *J* is not shown. Through shaft *E* and gear *J*, there is transmitted to rack *K*, fastened to table *L*, a reciprocating motion the extent of



Variable reciprocal arrangement operates a table at a distance from the nearest shaft line

which is determined by the position of rack *C* in disk member *A*.

It should be noted that because of changing angle of housing *D* during the cycle of the rack stroke the rate of acceleration and deceleration increases and decreases at the ends of the stroke, according to the direction in which disk member *A* is rotating.

—JOHN A. HONEGGER,
New York

Why Use a Metric System?

To the Editor:

WITH reference to the comments by Lloyd A. Whittaker and Frederick Franz in your June and August issues on the subject of ball bearings made to inch dimensions, the Norma-Hoffmann Bearings Corp. have available a number of different types of both ball and roller bearings made to inch dimensions and ranging from 1/8 to 21 inches bore. These are obtainable in extra light, a light and medium series.

—D. E. BATESOLE,
Stamford, Conn.

Noteworthy Patents

MAINTENANCE of uniform tension on strip insulation in a wire-covering machine is the subject of Patent No. 2, 033,625, issued to Stanley F. French, Dobbs Ferry, N. Y., assigner to Anaconda Wire & Cable Co.

The apparatus is shown, together with wiring diagram, in *Fig.* 1, as set up to handle strip fed from reel *B* and wrapped on wire *A*. There is relative rotation between wire and reel, either of reel around wire or by holding reel in one position and rotating the wire. Strip is drawn from reel *B* around idler roller *D*, carried on pivoted arms *E* and held by spring *F* tightly against reel *B*. It then passes over tensioning roller *G* which is connected to armature of tensioning motor *H*. Next, the strip is drawn around idler rollers *J* and *K*, thence passes to wire *A*.

Current is supplied to tensioning motor *H* from a main compound wound generator *L* having series coil *M* and shunt coil *N*. One generator terminal is grounded, while current from the other passes from series coil *M* through switch *O*, variable rheostats *P* and ammeter *Q*, thence to tensioning motor *H* which preferably has compound wound field consisting of series field coil and shunt field. Current is grounded beyond the motor thus completing the circuit.

Counter-Electromotive Force Is Set Up

Counter-electromotive force generated by rotation of motor *H* by passage of strip is compensated by decreasing the current through main generator shunt field winding *N* in proportion to this counter-electromotive force. Circuit through shunt field winding *N* leads to shunt wound compensating generator *T* having shunt field coil *U*, and returns through rheostat *V*. Speed of compensating generator is in proportion to that of strip—therefore in relation to motor *H*. The generator may be driven by wire *A*, its rotation thereby being maintained in di-

rect relation to tensioning roller *G*.

Various means of driving are indicated in the wiring diagram, in which motor *H* is shown driving shaft *W* carrying pulley *X*, and with generator *T* driven by shaft *Y* carrying drive pulley *Z*. The pulleys *X* and *Z* are driven from pulleys *BB* and *AA* on shaft *DD*. Where a number of strips are fed to a common wrapping device, all can be tensioned by current supplied by generator *L* and compensated by generator *T*. It is nec-

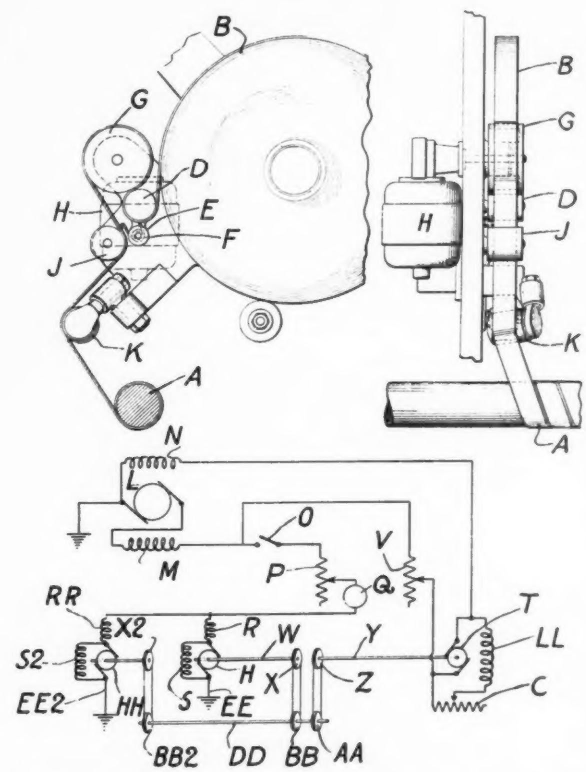


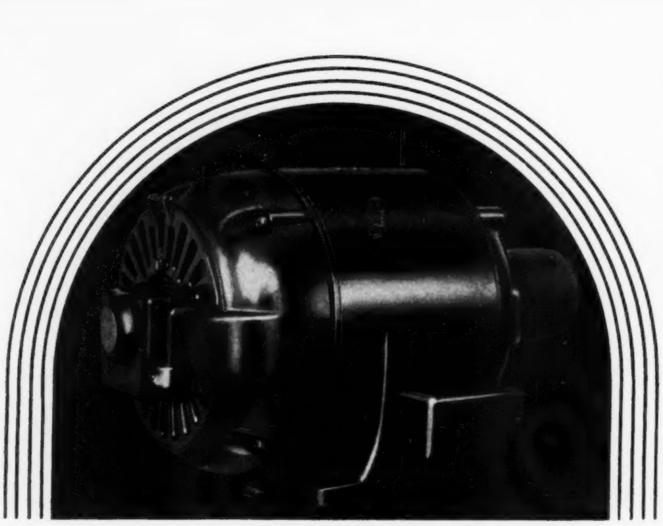
Fig. 1—Electric drive to wire covering machine maintains uniform tension on insulating strip

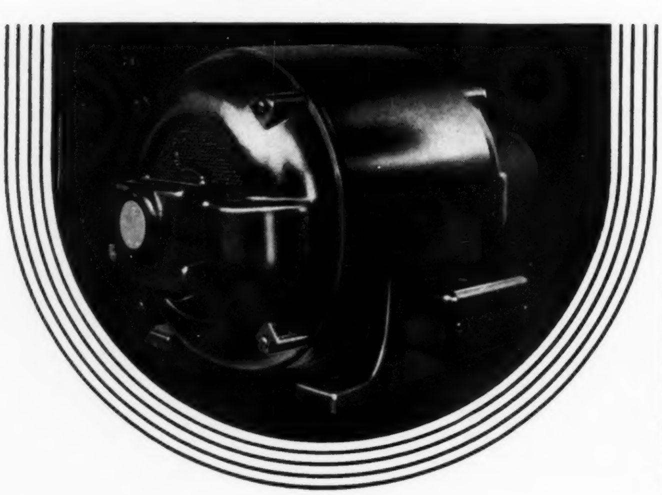
essary only to duplicate motor *H* as at *HH*, field coils *RR* and *S2*, connections *EE2*, and drive pulley *X2* and *BB2*.

MEANS for preventing escape of fluids under pressure beyond the journal of rotating shaft, are covered in a patent issued to George P. Gilman, Chicago, assignor to Rotary Seal Co.

This abstract deals with a type of seal which takes up minimum space lengthwise on the shaft. *Fig.* 2 shows a sectioned assembly together with an exploded view showing details. Wall *A* may be part of a machinery casting—that of a pump for instance—containing (at the left-hand side) fluid under pressure which must not be allowed to escape beyond journal *B* where rotating shaft *C* passes through.

The seal is made up of a flanged cup-shaped





element D loosely encircling the shaft. Its finished annular bead E bears against and forms a running seal with the finished shoulder of journal B. Within the counterbored space of cup D are housed a smaller cup-shaped element F and a sealing gasket G. Outside of cup F fits snugly within counterbore in D, its end resting against the bottom of the counterbore when no liquid pressure exists. Element F also is counterbored to form chamber H surrounding shaft C.

Gasket G rests against the front face of F, this face being grooved at K to retain liquid to assist in sealing. The gasket is retained by washer L which is anchored in place on the shaft by snap ring M in groove N in the shaft, cutting of groove N being the only modification necessary when applying the seal.

Spring O is interposed between outer flange on cup D and washer L. It presses bead E of cup D against inner shoulder of journal B. In the design shown, this spring surrounds the large cup D, thereby conserving space in chamber H.

The seal is designed to receive fluid which

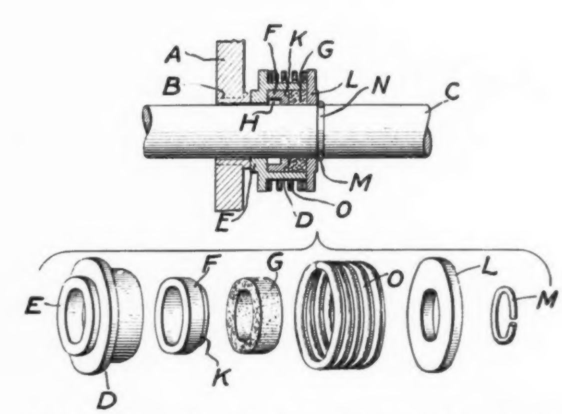


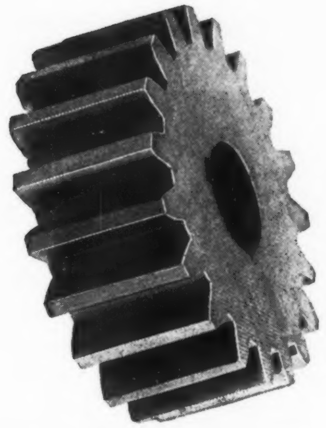
Fig. 2—This fluid seal for running shafts requires minimum machining for installation

escapes under pressure from left to right through journal B. This fluid pressure forces large cup D and small cup F in opposite directions. In other words they act as cylinder and piston aiding spring O to seat flange E firmly against the shoulder of journal B, at the same time packing gasket G firmly around the shaft.

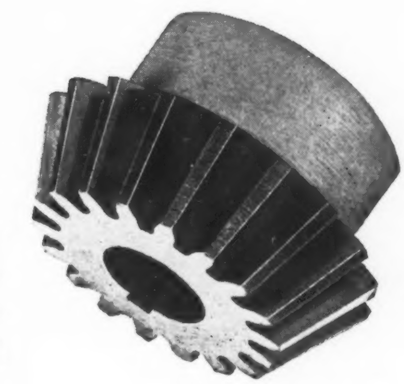
This patent is identified by No. 2,025,279.

TURNING of eccentric work in multiple spindle automatics is the purpose of a fixture patented by C. H. Hoisington and Robert Beacom, assigned to National Acme Co., Cleveland.

The device is located in a saddle bolted to the tool slide of the machine so that it travels



FORMICA MAKES MACHINES *Easier To Sell*



FEW points about machinery are more important to a salesman than silent smooth operation, and that is why more and more machinery manufacturers are using Formica gears to quiet their drives. Formica helps to sell the machines.

For the same reasons maintenance men who have to keep machinery in good shape like to replace noisy metal gears with Formica. The material is sufficiently elastic to take up a lot of jolts and jars, protect the mechanism, and assure longer life.

The gear cutters named can give prompt service on one or many Formica gears.

THE FORMICA INSULATION CO., 4640 Spring Grove Ave., Cincinnati, O.

FORMICA

FORMICA GEAR CUTTERS

The Akron Gear & En'g Co.
Akron, Ohio
Farrel-Birmingham Co., Inc., Buffalo, N. Y.
Slaysman & Company
Baltimore, Md.
Harry A. Moore
Bangor, Me.
The Union Gear & Mch. Co.
Boston, Mass.
The Atlantic Gear Works
New York City
Chicago Rawhide Mfg. Co.
Chicago, Ill.
Perfection Gear Company
Chicago, Ill.
The Mechanical Specialty Mfg. Co., Chicago, Ill.
Merkle-Korff Gear Co.
Chicago, Ill.
Chicago Gear Works
Chicago, Ill.
The Cincinnati Gear Co.
Cincinnati, O.
The Horsburgh & Scott Co.
Cleveland, O.
The Stahl Gear & Machine Co., Cleveland, O.
The Master Electric Co.
Dayton, O.
The Adams Company
Dubuque, Ia.
The Ferguson Gear Co.
Gastonia, N. C.
Hartford Special Mchny. Co.
Hartford, Conn.
Beaty Machine Works
Keokuk, Ia.
The Generating Gear Co.
Milwaukee, Wis.
Badger State Gear Co.
Milwaukee, Wis.
Precision Machine Co.
Milwaukee, Wis.
E. A. Pynch Co.
Minneapolis, Minn.
Joaquin Alemany Lopez
Havana, Cuba
New Jersey Gear & Mfg. Co.
Newark, N. J.
Prager, Inc.
New Orleans, La.
J. Morrison Gilmour
151 Lafayette St.
New York City
Sier-Bath, Inc.
New York City, N. Y.
E. M. Smith Machine Co.
Peoria, Ill.
The Eagle Gear & Mch. Co.
Philadelphia, Pa.
Rodney Davis and Sons
Philadelphia, Pa.
The Pittsburgh Machine & Supply Co., Pittsburgh, Pa.
Standard Gear Co.
Pittsburgh, Pa.
H. W. Honeymon & Son
Providence, R. I.
Perkins Machine & Gear Co.
Springfield, Mass
Winfield H. Smith, Inc.
Springbille, N. Y.
Alling Lander Company
Sodus, N. Y.
Charles E. Crofoot Gear Corp'n, South Easton, Mass.
Arlington Machine Co.
St. Paul, Minn.
Farwell Mfg. Co.
Toledo, Ohio
Diefendorf Gear Corp.
Syracuse, N. Y.
Worcester Gear Works
Worcester, Mass.
Massachusetts Gear & Tool Co., Woburn, Mass.

back and forth with the slide. As shown in *Fig.* 3, cylindrical head *A* which has a flanged end *B*, is located in the saddle. At *C* is a drive shaft rotated by some means such as a gear train from the main shaft of the machine. In automatics on which this fixture is used, the main shaft extends through an indexing work spindle carrier and by means of gearing rotates the spindles at predetermined speed. Thus shaft *C* and the spindles rotate at the same speed and direction. Drive shaft *C* is mounted within cylindrical head *A* on roller bearings *D*. At its forward end is an eccentric stud *E* projecting through elliptical opening *F* into a flanged opening *G* of slide *H*. Roller bearings for stud *E* are shown at *I*.

Slide *H* has a projection *J* on which turning tool *K* is mounted. This slide is held in flanged

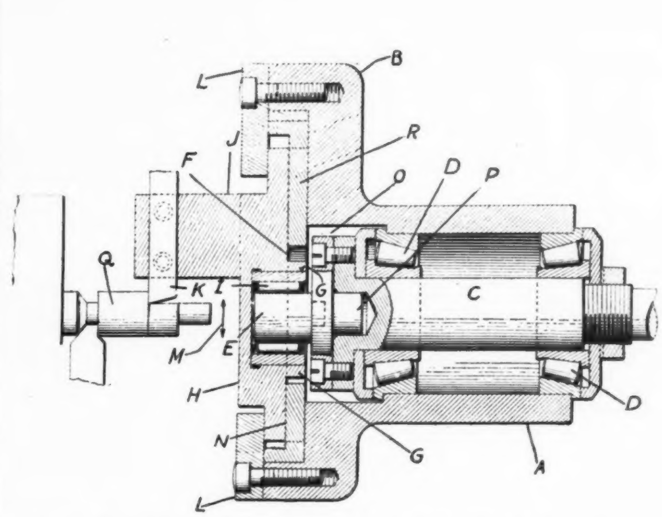


Fig. 3—By means of a reciprocating slide this tool performs eccentric turning in an automatic

portion *B* by gibs *L* so that it can move horizontally as shown by double arrow *M*. The rear of the slide has a milled recess *N* in which a secondary slide operates vertically, thus providing compound movement. Eccentric stud *E* has a flanged head *O* bolted to shaft *C*. This head also has a concentric stud *P* located in shaft *C*, shaft and stud being in alignment with the center line of the work. Interchangeable studs are provided to give varying eccentricities.

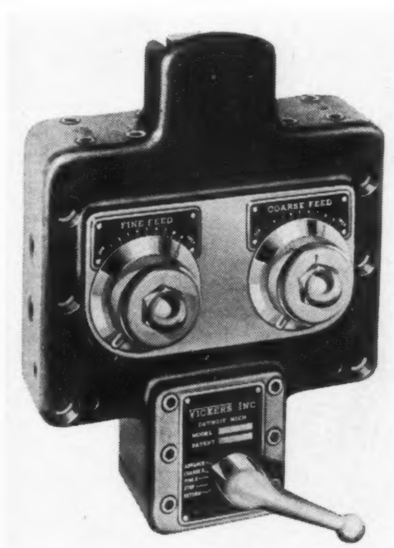
Rotation of the eccentric stud by the drive shaft tends to impart a circular motion to the slide *H* carrying the cutting tool but since slide *H* is prevented from rotating by the other slide *R*, it can only move vertically and horizontally. This compound motion keeps the cutting edge of the tool on the center line of the work. The tool moves radially with the eccentric work so that it always cuts along the center line of the work.

This patent is identified by No. 2,039,646.

NEW *Materials and Parts*

Control Enables Varying Cycles

ADAPTABLE to a wide variety of cycle requirements, the new feed control panel of Vickers Inc., 1400 Oakman boulevard, Detroit, will provide any cycle sequence as made up of rapid advance, adjustable coarse feed, adjustable fine feed and rapid return motions. The main internal control valve of the panel, shown herewith, is actuated by one of three interconnected means: Manually by the lever shown, mechanically by trip cams on moving platen or head contacting the plunger roller at the top of the panel, and electrically by energizing solenoid separately mounted behind the unit. The starting of the cycle into rapid advance can be accomplished by manual movement of the control lever if the panel is convenient to the operator's station, or remotely by pushbutton or other electrical contact means. Change from rapid advance to feed is normally accomplished by a cam or cams contacting the plunger roller at desired points.



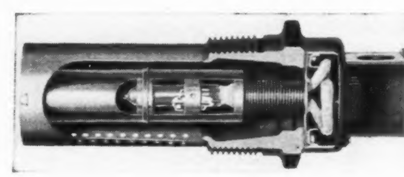
A wide variety of feeds and speeds is possible with feed control panel designed for hydraulic control in co-operation with electrical controls

If two feed rates during the cycle are required, the first cam usually depresses the plunger to correspond with the "Coarse feed" valve position and another depresses to "fine feed" position at the proper time, although other combinations can be worked out if conditions

demand. A great many other combinations are possible with the panel, such as a jump feed cycle. When the end of the forward stroke is reached, a limit switch or pressure switch must be actuated. This energizes a solenoid causing the main valve on the panel to be shifted to the rapid return position. An automatic stop action after the return stroke is obtained by a hook cam pulling the plunger back to the stop position.

Control Incorporates Mercury Switch

A SIMPLE float-operated switch for the control or checking of liquid levels has been developed by McDonnel & Miller, Wrigley building, Chicago. The working mechanism, as shown by the accompanying cut-away view, consists of a mercury switch inside of the float which is attached to the head by means of flexible metallic bellows. As the float switch moves through its arc, the mercury switch makes and breaks contact. The unit shown can be screwed in a horizontal position directly into a tank or vat, and at any desired height. When the liquid level reaches a height that will move the float, the mercury switch makes contact to sound an alarm, light a warning light, or may be used to start up a motor-operated pump or other electrical device. It may also be installed at a predetermined low level to cut in a motor-pump unit or sound an alarm as required.



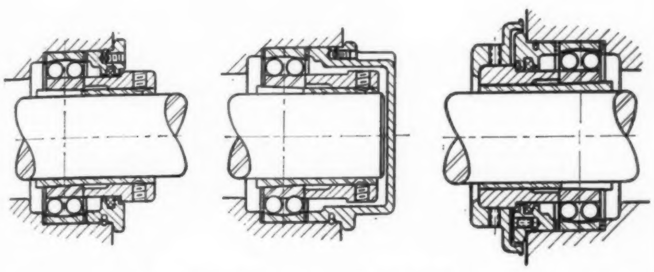
Mercury switch makes and breaks contact as float moves through an arc

Bearing Application Facilitated

MACHINE units designated to facilitate the installation of ball bearings in many kinds of equipment have been developed by Ahlberg Bearing Co., 321 East Twenty-ninth street, Chicago. These units, shown herewith, give the designer a simple means of using ball bearings in equipment where the bearing housing is either a part of the machine or must, of necessity, conform to the manufacturer's design. Three capacities are available for a given shaft size, in two styles. All are equipped with self-aligning

ball bearings which enable these units to automatically and instantaneously compensate for normal inaccuracies in assembly and for shaft deflection.

End caps in the 2100 series are provided with a large felt seal. The 23000 and 25000 series have an additional labyrinth arrangement which, in combination with the felt, provides an especially effective seal. Flingers are available



Improved units give the designer a simple means of applying ball bearings to his equipment

where an additional seal is required. The 21000 series locks to the shaft by two setscrews in the inner ring of the bearing. The 23000 series, shown herewith, and the 25000 series are equipped with a split adapter sleeve which is drawn into the tapered bore of the bearing by the action of four setscrews. This action wraps the sleeve over its entire length around the shaft and locks it in position.

Closed end caps, as shown in the center of the illustration, are available in place of the open caps.

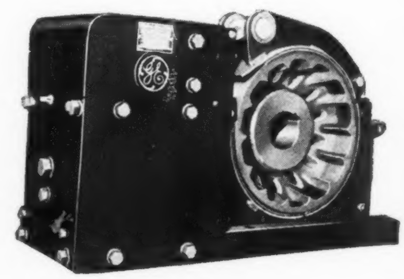
Improves Brake Mounting Flexibility

MOUNTING flexibility of the two-shoe brake is combined with the braking surface protection of the band-type brake in the three-shoe, spring-set, direct current magnetic brake brought out by General Electric Co., Schenectady, N. Y. The new brake, shown herewith, is designated as the type CR9523 three-shoe brake. It is intended for use with steel mill machinery, cranes, hoists, conveyors, and in places where it is necessary to stop and hold a load at the motor armature. The frame is of bar and plate stock steel, welded for strength.

Peripheral length of the brake lining, over 85 per cent of the wheel periphery, is greater than that of either the conventional band or shoe-type brake. The protection against dust and dirt thus afforded greatly reduces wear on the wheel and lining. Brake shoes are self-aligning, and braking in either direction of rotation is equal. A specially developed spring for brake setting gives low build-up, and the resultant

smooth braking action reduces mechanical stresses on the equipment. Desired braking characteristics are obtained by adjusting the position of the shoes and the compression of the spring.

The actuating mechanism uses a clapper-type magnet, the operation of which is not impaired

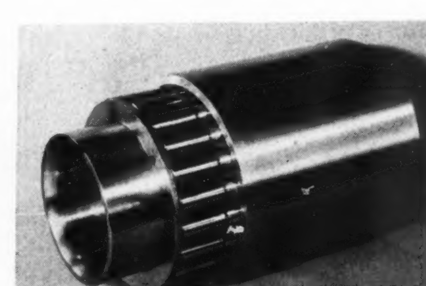


Specially developed spring in new brake gives low build-up and resultant smooth braking action

by ordinary accumulations of dust and dirt. This construction assures positive operation under the severe conditions found in mill service. All adjustments are accessible from the top of the brake. When the top brake shoe is disconnected from the operating rod, the brake wheel may be lifted vertically from the shoe without disturbing the brake setting.

Extends Roller Bearing Range

HEAVY-DUTY industrial roller bearings in an extended range of almost a hundred sizes are now being manufactured by Fafnir Bearing Co., New Britain, Conn. The rated capacity of these bearings ranges from 10,000 to 500,000 pounds, depending upon size, speed and loading conditions. The series is said to cope fully with



A large number of solid rolls are incorporated in the cage assembly of this extended line of roller bearings

the severe service requirements of paper mills, steel mills, and other heavy metalworking machinery, rubber and oil field equipment, and the like.

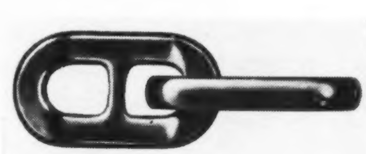
In the widened range of bearing sizes, rollers of ¾-inch, 1¼-inch and 1½-inch diameter have been utilized in addition to the 1-1/16-inch diameter used in the bearings previously available. A

choice of eighteen different bores is now offered in bearings of this type.

A feature of these roller bearings is the large number of solid rolls which are incorporated in the cage assembly. The cage itself is fabricated from specially form-rolled spacer bar stock, with carburized and hardened end rings. Rollers are held in place and guided by spacer bars rather than by rivets through the rolls themselves. The spacer bars are riveted to the end ring, and the accurate assembly of these bars keeps the rolls permanently aligned.

Redesigns Hoisting Chains

CAST manganese steel drag-line bucket pulling and hoisting chains of a new design have been introduced by American Manganese Steel Co., Chicago Heights, Ill. Full line instead of point bearing between links is provided by the new chains which also have additional metal on sides of links where abrasive wear



Improved chain is lighter in weight than previous design

comes. Despite this additional use of metal, the improved design is lighter in weight than previous chains of this type. A tie bar is used across the link to prevent snarling and kinking.

The chains are made of heat-treated austenitic manganese steel which is said to combine strength, toughness and wear resistance. All metal sections are equalized to aid in securing uniform heat treatment. Of distinctive design, the lines of the chain are kept simple to insure clean castings.

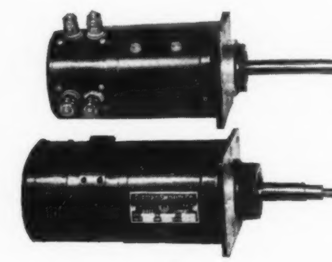
Motors Designed for Special Uses

TO PROVIDE satisfactory electrical operation of the wing flaps and for raising the landing gear on modern planes, Electric Specialty Co., Stamford, Conn., has recently produced two new motors of novel design. The motors, shown herewith, operate from the storage battery on the plane, and, due to the comparatively low input current and short time of operation, the drain on the battery is negligible. Flange mountings to fit the pump for raising the landing gear hydraulically and to fit the gear unit

for operating the wing flaps assure rugged and compact units.

Commutators of special materials and with a large number of segments and brushes of special composition are employed to reduce wear and frequency of replacement. Shutters provide pro-

Aircraft control motors are especially designed for unique applications

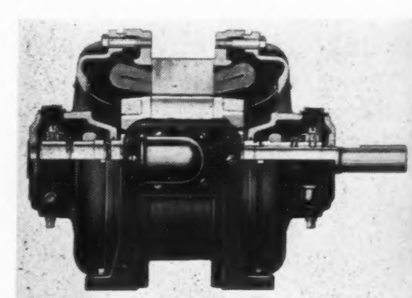


tection of the commutator and the brushes and at the same time permit easy access for inspection and cleaning. The terminals may be mounted radially and exposed, or axially and protected with removable shutters.

Designs Squirrel-Cage Motor

RIVETED-FRAME squirrel-cage polyphase induction motors of new design in frame sizes of from one to fifteen horsepower at 1800 RPM have recently been placed on the market by General Electric Co., Schenectady, N. Y. The new motors, available in a variety of electrical and mechanical modifications, incorporate improvements in stator-coil insulation, frame con-

Recently developed insulating materials and processes are utilized in new insulation system for this motor

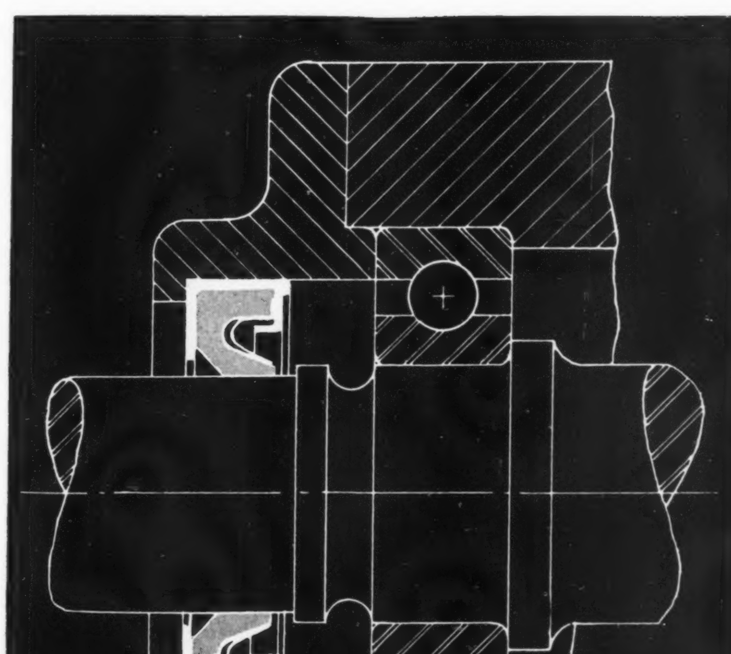


struction and other design features. Co-ordination of design permits the different modifications of motors in the line to be used interchangeably for many types of power supplies and for various applications requiring open, sleeve or ball-bearing, enclosed, enclosed fan-cooled, splashproof, vertical motors, etc. As a result of this adaptability, many special requirements may be met with the standard available line.

A new insulation system "built from the inside out" is employed for the stator-coil windings which are of the random-wound type, with joints at the connections fused instead of soldered. Recently developed insulating materials

PATENTED—Garlock KLOZURES are fully protected by patents. Made in a complete range of sizes for every type of oil seal application.

The *Garlock* KLOZURE RESISTS Oil and Heat



A typical KLOZURE application.

Because it does not "soak up" oil and become soft and flabby and because it is unaffected by higher temperatures frequently encountered in oil seal service, the KLOZURE sealing ring effectively *resists oil and heat* under all conditions. This special Garlock compound is dense, grainless, non-abrasive and tough.

No heavy springs are required, as the KLOZURE sealing ring is inherently resilient. Accordingly, construction is simple and compact—*practical* as well as efficient. Write for booklet.

THE GARLOCK PACKING COMPANY
PALMYRA, N. Y.

In Canada: The Garlock Packing Company of Canada, Ltd.
Montreal, Que.

and processes are utilized, eliminating the need for taping the end windings and producing an insulation assembly with high resistance to moisture and other common deleterious influences such as mild acids, alkalis, oil and abrasion.

A new riveted-frame construction and new end frames of malleable iron, with integrally cast feet, contribute to the strength and rigidity of the motors, providing increased resistance to vibrating and shock loads. Cast iron end shields of ample strength maintain accurate bearing alignment and uniform air gap.

Plastic Withstands High Heating

IMPROVED heat-resistant material which is said to be unaffected by temperatures up to 450 degrees Fahr. is a recent development of General Plastics Inc., North Tonawanda, N. Y. This new material, available in black and brown and known as No. 34 and No. 37, is intended for parts which must retain their dielectric strength without carbonization under relatively high heat. The material performs well, molds almost as fast as standard materials, and has excellent arc resisting properties as well as a smooth finish. It also has a low water absorption rate.

Timers Are of Improved Design

DESIGNED especially for standard equipment installation, the improved type No. 75CH timer of Walser Automatic Timer Co., Graybar

Patented concenter switch features this automatic timer for standard equipment

building, New York, has a type of switch and method of operation radically different from any heretofore employed in the company's automatic timers. With the new timer, shown herewith, it is not necessary to reset the dial pointer after

it has been turned far enough to throw the switch for interval settings of short duration, as required in previous designs. Correct interval setting is promoted by use of a knobbed dial which is turned in place of the usual pointer around a fixed dial scale.

An unusual feature of the design is the patented cone-center principle switch developed and manufactured by Cutler-Hammer Inc. The fine silver, floating butt-type contacts, with six breaks in series, provide a quick make and break and positive contact under all conditions. As the switch circuit opens and closes independently of the clock movement, no extra power is required to operate the switch, and the clock escapement operates at an even rate at all times.

Announces New Trade Name

ALLOY steels produced by Carnegie-Illinois Steel Corp., Pittsburgh, are to be identified in the future by a new trade name, "USS Carilloy." The new name does not signify a new product, nor does it apply to a single alloy steel. It is simply a new trade designation which will serve as a quality trademark for the entire group of alloy steels previously marketed as "Carnegie-Illinois Alloy Steels."

Live Rubber Supports Motors

LIVE rubber in shear carries the motor in the new resilient mounting base for fractional horsepower motors developed by Bodine Electric Co., Chicago, Ill. Rubber in shear is

Rubber in shear is employed to support motor and to aid in overcoming vibrations

a more efficient absorber of vibration than rubber in compression or tension, and the new base is said to give the utmost in quietness and freedom from vibration. Despite the high resilience the mounting is unusually stable. Measurements have shown that a bending torque on the shaft changes the relative position of the motor frame but slightly.

Engineering Department Equipment

Drafting Machines Easily Employed

EACH of the new drafting machines now being manufactured by Charles Bruning Co. Inc., 102 Reade street, New York, is equipped with an adjustable brake to prevent the protractor head from sliding excessively when used on an inclined board. The machines also have adjustable skid buttons for leveling the scales. Pulleys are fully enclosed, and bands may be changed if necessary without disassembling the machine. Fully-enclosed precision ball bearings, lubricated for life, are used in the equipment, shown herewith. Another exclusive feature of the units is an elbow leveling device designed into each model. All parts are of dull finish aluminum or baked enamel, thus eliminating reflection.

The standard protractor model of the drafting machine is designed for the use of mechanical designers, and for architectural and structural

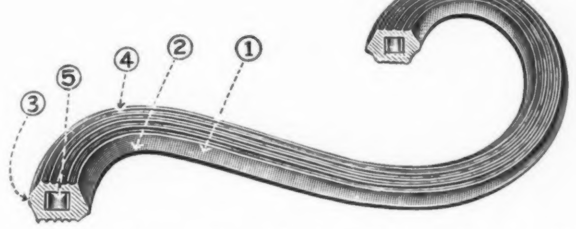
Adjustable brake on drafting machine prevents the protractor head from sliding excessively

work. Other models include a civil engineers' model for map draftsmen and navigators, and a deluxe civil engineers' model which includes a micrometer adjustment screw tangent to the protractor.

Curves Can Be Accurately Adjusted

METAL impregnated rubber is used for the cover of the adjustable curve being manufactured by Wade Instrument Co., 2274 Brooklyn Station, Cleveland. With this construction, as shown herewith, and with the point contour of the sides, pen and pencils slide freely. The low drawing edge 2, on one side of the curve, is designed close to the paper while the under-

cut prevents ink blots. On the opposite side of the curve at 3, there is a center drawing edge for opposite curves and for two or more paral-



Base of this new adjustable curve is a lead core held between spring steel strips

lel lines at one setting. The base of the curve is a lead core held between two spring steel strips. Curves, once formed, can be held exactly to the predetermined contours, while corrugated top and bottom act to prevent slippage.

Reflector Focuses Light

A SCIENTIFICALLY designed reflector of spun Alzak aluminum reflects the light rays into a converging beam which brings the light to a focus about 15 inches ahead of the reflector in the Uni-focal lamp introduced by Fostoria Pressed Steel Corp., Fostoria, O. Uni-

Effective shielding of bright light source eliminates glare from lamp which has scientifically designed reflector

form and intensified illumination over a restricted area results, but glare is eliminated by the effective shielding of the bright light source. Directing the light is the supporting arm as shown with ball and socket joints that permit focusing of light on working surfaces from any angle or direction without tightening or loosening joints. The oil-resisting light cord is carried inside the supporting arm with a positive lever switch in the handle grip on the reflector.

MEETINGS *and* EXPOSITIONS

Oct. 19-23—

National Metal Congress and Exposition. Extensive exhibition and discussion of materials and processes to be held at Public Auditorium, Cleveland. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is managing director.

Oct. 19-23—

American Society of Metals. Annual meeting to be held at Cleveland. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is secretary.

Oct. 19-23—

American Welding society. Annual meeting to be held at Hotel Cleveland, Cleveland. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary.

Oct. 19-22—

American Institute of Mining and Metallurgical Engineers. Fall meetings of institute of metals and iron and steel divisions to be held at Hotel Statler, Cleveland. Louis Jordan, 29 West Thirty-ninth street, New York, is secretary.

Oct. 19-23—

Wire association. Annual meeting to be held at Cleveland. R. E. Brown, 17 East Forty-second street, New York, is secretary.

Oct. 19-24—

National Business Show. Exhibition of office machinery and equipment to be held at Commerce Hall, Port Authority building, New York. Frank E. Tupper, 50 Church street, New York, is in charge.

Oct. 22-23—

American Society of Mechanical Engineers. Technical meetings of the machine shop practice, iron and steel, process and petroleum divisions to be held in connection with the Metal Congress. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary of the society.

Oct. 26-30—

American Gas association. Annual meeting and exhibition of machinery to be held at the Auditorium, Atlantic City, N. J. Kurwin R. Boyes, 420 Lexington avenue, New York, is secretary.

Oil Pressure Regulates Propeller Pitch

(Concluded from Page 41)

RPM is more than that desired, such as occurs momentarily when the plane is nosed down into a dive, or when the throttle is opened rapidly. In the third case, "On Speed", *Fig.* 3, RPM is exactly that for which the control is set.

In the speed control, a pilot valve moves up and down in a cylinder in response to the action of flyweights working against the tension of a spring referred to as the "RPM spring". The flyweights are driven by the engine in proportion to engine speed; the tension of the spring is controlled by the pilot of the plane. Obviously the greater this spring tension is, the faster the flyweights must rotate before they can compress the spring upward. When they are not rotating fast enough to accomplish this, the spring forces the pilot valve downward so that it uncovers the port leading to the propeller feed line as shown in *Fig.* 1. This allows oil under pressure from the pump to flow to the propeller, decreasing its pitch.

Flyweights Compress the Spring

When the flyweights are rotating faster than the speed for which the spring tension is set, they compress the spring, carrying the pilot valve upward, opening the propeller port and allowing the oil in the propeller cylinder to drain back to the engine. This shifts the propeller toward high pitch as shown in *Fig.* 2. The "On Speed" condition, *Fig.* 3, results when the rotation of the flyweights is just sufficient to balance the spring tension and hold the pilot valve so that it closes the propeller port. Under these conditions the pitch remains constant. This is the stabilized condition.

The booster pump is a simple gear-type driven by the engine. Oil from the engine pressure system feeds into it and is boosted to higher pressure. This high pressure oil fills the space between the necked-down section of the pilot valve and the walls of the cylinder, and backs up against the spring-loaded relief valve. When the pressure builds up to about 180 pounds per square inch the relief valve opens allowing some of the oil to circulate around the pump and come back into it again on the low pressure side, the same oil being used over and over without drawing on the engine lubricating supply. Only when the pilot valve moves down as shown in *Fig.* 1 does any of the oil flow out to the propeller, and in this case only is there a demand for more oil from the engine supply. At all other times, the relief valve stays open to maintain 180-200 pounds per square inch pressure.

Topics of the Month

(*Concluded from Page 26*)

We accept improved design so quickly, and come to consider it as the standard practice, that it is often hard to realize the comparatively short length of time required to perfect machines. For example, just twenty-five years ago an intrepid aviator amazed the country by making the first transcontinental flight in fifty days. Since that time, aviation has been one of the most fertile fields for design ingenuity. Today air-express at a speed of three-miles-a-minute is accepted as an ordinary achievement. And machinery builders are using this means as reflected by the fact that during a recent month over seven hundred machinery parts were air-expressed.

* * *

One of the prime purposes of good design is to make work easier and recreation happier. Now a portable radio has been developed which can be carried around easily. Its use permits one to be one place and hear the happenings at another. For example, you could watch a prize fight while listening to a baseball game!

* * *

Human comfort is also an important design aim. In this field designers have created air conditioning, the one important industry to rise throughout the depression. Now comes an improvement which represents a marked advance in methods of moving large volumes of air silently. Because propeller type fans are inherently not suited to the type of work demanded by the more complex central plant air conditioners, this GE fan creates the higher pressures required by rotating the air so that each particle of it is subjected to centrifugal force. Although this principle is not new, there previously were no fans capable of imparting the required velocity to the air, turning it at the same time through the required angles, without creating innumerable eddy currents and conflicts within the air stream. This turbulence causes unnecessary noise. In the new design the air traverses the fan blades in a radial direction.

* * *

Together with good air, man's most pressing need in this day of modern cliff dwellers is sunlight. The *New York Times* tells us of a machine which is prepared to satisfy this need. In this device a mirror reflects the sun's light into airshafts. The mirror is mounted in a frame so that it can swing to any angle, horizontal or vertical. On the same frame are mounted little electric motors, only 1/100 horsepower, which turn tiny propellers like those of a model airplane. When they go into action, the propellers push or pull the frame around so that the mirror makes the desired angle with the sun. The motors are controlled by mercury switches which are contained, together with gas, in glass bulbs. When the sun strikes these bulbs they function like quick-acting thermometers. The mercury is pushed around to the point where it closes an electrical circuit that starts one of the propeller-motors, thus swinging the mirror after the sun; if the mirror swings too far, the propeller automatically goes into reverse.

MANUFACTURERS' PUBLICATIONS

ALLOYS (NICKEL)—The properties and applications of heat treated wrought nickel alloy steels in sections up to about 6 inches in diameter or thickness are completely presented in descriptive, chart and tabular form in bulletin P-1 of International Nickel Co., 67 Wall street, New York. The booklet also includes photographs and descriptions of typical applications of the material.

ALLOYS (STEEL)—Driver-Harris Co., Harrison, N. J., has just prepared a new booklet, R-36, as an aid to those upon whom rests the responsibility for the proper selection of alloys used for electrical, mechanical and chemical purposes. The book gives complete details of the properties and characteristics of a number of the alloys, and includes several comprehensive tables.

ALUMINUM—Aluminum Co. of America, Pittsburgh, is distributing a most attractive and complete booklet on finishes for aluminum. This well-prepared publication discusses mechanical finishes, chemical dip finishes, electrolytic oxide finishes, electroplating on aluminum, Alclad products, and paint, lacquer and enamel finishes.

BEARINGS—The application of tapered roller bearings and complete design data on these applications to landing wheels, tail wheels, swivels and rocker arm assemblies are given in the recently issued aircraft section of the "Engineering Journal" of Timken Roller Bearing Co., Canton, O.

BEARINGS—Retainers for ball bearings which simplify the installation of these parts and reduce the amount of machining necessary are described in a new bulletin of Ahlberg Bearing Co., 321 East Twenty-ninth street, Chicago. Many of the retainers act as closures to completely seal in the bearing.

BEARINGS—The application of tapered roller bearings to various types of rolling mills, screwdowns, pinion stands, gear drives, table rolls, reels, straighteners, levelers, hot saws, cranes and cars is adequately described and illustrated both with photographs and cross-sectional drawings in a new publication of Timken Roller Bearing Co., Canton, O., entitled "The Answer to Rolling Mill Bearing Problems." Another publication of the company discusses in detail the recommended practice for assembling Timken bearings of various types, their repair, adjustment and lubrication. This publication, which includes charts, photographs, and diagrams, is entitled "Maintenance and Lubrication of Bearings in Rolling Mill Equipment."

CAST PARTS—Farrell-Cheek Steel Co., Sandusky, O., has prepared a bulletin which gives complete details and the physical properties on its line of cast steels, both alloy and regular grades. The bulletin also explains the meaning of the physical properties.

CLUTCHES—Disk clutches in a variety of types are

presented in bulletin L 28 of Conway Clutch Co., 1500 Queen City avenue, Cincinnati, O. The clutches described and illustrated by cross sectional drawings include: Single plate, stud drive with extended sleeve; tandem plate, stud drive with extended sleeve; single plate, stud drive with extended sleeve, heavy duty design, tandem plate, heavy duty design, gear tooth drive.

DRIVES—Janette Mfg. Co., 558 West Monroe street, Chicago, is distributing a folder on its line of motorized speed reducers which presents the various models available and gives reasons for their use.

DRIVES—Complete details on the method of operation and the application of infinitely variable speed transmissions manufactured by Lenney Machine & Mfg. Co., Warren, O., are given in a new publication of the company. In the drives, a hardened steel roller in pressure contact with an equally hardened steel driving disk is used to transmit power.

DRIVES—Silent chain drives, roller chain, sprockets and couplings are presented in a form which simplifies their application in the new publication of Morse Chain Co., Ithaca, N. Y. The bulletin includes drive tables which enable the designer to select the exactly correct chain drive for his application.

DRIVES—D. O. James Mfg. Co., 1114 West Monroe street, Chicago, presents complete engineering and application details on its line of right-angle spiral bevel spur gear speed reducers in catalog 141 which includes cross-sectional drawings showing the units. Another publication of the company, bulletin No. 16, covers right-angle spiral bevel continuous-tooth herringbone speed reducers. This bulletin also gives complete data on this type of drive.

ELECTRICAL EQUIPMENT—A new 12-page booklet, B-2078, describing the selection and application of Rectox copper oxide rectifiers for changing alternating to direct current without moving parts or chemical reaction is being distributed by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

INSTRUMENTS—General Radio Co., Cambridge, Mass., has prepared Catalog J which gives complete information on the line of stroboscopes, color comparators, sound level meters and adjustable transformers which the company manufactures. Other parts covered by the catalog include frequency and time measuring devices, oscillographs, resistors, condensers, inductors, generators and oscillators.

INSULATING MATERIALS—Information and recommendations on high and low temperature insulations for every industrial need are included in a recent publication of Johns-Manville, 22 East Fortieth street, New York. One of the topics discussed is the sound control of mechanical equipment.

ISOLATION PRODUCTS—A publication devoted to the study of sound proofing and the isolation of machine vibrations entitled "Isolation" has been prepared by Korfund Co. Inc., 48-15 Thirty-second place, Long Island City, N. Y. Included in the bulletin is a discussion of cork as an isolating medium.

HYDRAULIC EQUIPMENT—Vickers Inc., 1400 Oakman boulevard, Detroit, has prepared bulletin 36-10 on its new feed control panel for those rapid traverse and feed hydraulic circuits with which remote electrical con-

trol may be used advantageously. The bulletin gives the data necessary for the inclusion of the panel in the design.

MOTORS—Riveted-frame squirrel-cage polyphase induction motors of distinctly new design which incorporate improvements in stator-coil insulation, frame construction and other features are presented in new bulletins of General Electric Co., Schenectady, N. Y., which cover general purpose squirrel-cage, totally enclosed fan-cooled induction, totally enclosed hoist, explosion-proof totally enclosed fan-cooled, totally enclosed induction, and splash-proof induction types.

Research Publications

Investigations in Film Lubrication, by A. S. T. Thomson. This paper describes an experimental investigation of the operating conditions of centrally loaded clearance journal bearings as carried out on a new testing machine fitted with a 2½-inch diameter shaft. Nine bearings were investigated, comprising three arcs, 180, 90 and 60 degrees, and three lengths, 4, 2 and 1 inches, for each arc. The results of the complete investigation are compared with recent experimental and theoretical work, and expressions and curves are developed which might serve as a guide in bearing design. Published by Institution of Mechanical Engineers. 32 pp.

Development of Draft Gears for American Freight Cars, by W. E. Gray and C. W. Messersmith. A most complete review of the developments which have led to the modern freight-service draft gear is given in this publication which discusses each type of draft gear extensively. A system of classifying draft gears is presented for whatever worth it may have in the future. So far as is known, no one has previously proposed a classification system. Published as Research Series No. 54 by Engineering Experiment Station, Purdue University, Lafayette, Ind. 144 pp.

Reflectance Test for Opaque White Porcelain Enamels. This reflectance test booklet is a tentative standard for conducting reflectance tests. It discusses reflectance tests for individual specimens, determination of reflectivity and coefficient of scatter, commercial classification of enamel frits with respect to reflectance, and relation of certain constants to other reflectance characteristics. A diagram shows the interrelation of reflectance, reflectivity and opacity. Published by Technical Research section, Porcelain Enamel Institute Inc., 612 North Michigan avenue, Chicago, 7 pp. 10 cents.

Papers Presented at the First Annual Conference on Air Conditioning. Topics covered by this symposium include "What is Air Conditioning," "Comfort Conditions and Physiological Factors in Air Conditioning," "Air Conditioning and Its Effect on Hay Fever and Pollen Asthma," "Physical Factors Affecting Comfort," "Air Filters in Air Conditioning Systems," "Air Conditioning Equipment," "Essential Features of Heating Systems," "Estimating the Humidification Requirements of Residences," "Factors Affecting Fuel Saving," "Calculation of the Refrigerating Load," and "Research in Summer Cooling at the University of Illinois." Published as circular No. 26 by Engineering Experiment Station, University of Illinois, Urbana, Ill. 154 pp. 50 cents.

Business and Sales Briefs . . . .

J. E. BUCKINGHAM has been elected vice president in charge of sales for the Western district of Lincoln Electric Co., Cleveland. Headquarters for this sales office are located in the Straus building, 310 South Michigan boulevard, Chicago.

* * *

Foote Bros. Gear & Machine Corp., Chicago, has appointed Thomas Lord as sales engineer in the Detroit territory.

* * *

Frederick O. Schramm has been named district sales agent for New York and vicinity by Pittsburgh Steel Foundry Corp., Glassport, Pa. Mr. Schramm will maintain offices at 11 West Forty-second street, New York.

* * *

Reynolds Molded Plastics division of Reynolds Spring Co., Jackson, Mich., has opened a sales office at 90 West street, New York, to handle applications and sale of plastic parts in the Eastern section of the country. The office is in charge of Herbert S. Reynolds Jr.

* * *

Ralph Fisher, formerly of Houdaille-Hershey Corp., has been appointed sales manager of the stamping (Eaton Detroit Metal Co.) and bumper divisions of Eaton Mfg. Co., with headquarters at 9771 French Road, Detroit. The Eaton company has stamping plants located at Cleveland and Massillon, O.

* * *

James R. Buchanan has been added to the field metallurgical staff of the Detroit district sales office of Union Drawn Steel Co., Massillon, O. Mr. Buchanan was formerly associated with the metallurgical department of the Chevrolet Motor division of General Motors Corp., Flint, Mich. He joined the Union Drawn company in April.

* * *

George W. Duncan, who was connected for sixteen years with the fractional horsepower department of General Electric Co. at Fort Wayne, Ind., has joined the sales staff of Ohio Electric Mfg. Co., Cleveland, as assistant motor sales manager. D. M. Fraser, president of D. M. Fraser Ltd., Toronto, Ont., Canada, has been appointed motor sales representative for Canada by the Ohio company. H. Vearncombe is associated with Mr. Fraser.

* * *

William F. Henning has been appointed domestic sales manager of American Screw Co., Providence, R. I. Mr. Henning has been assistant manager of this department for fifteen years and succeeds to the post vacated by the death of Albert B. Peck. Walter Bromley, formerly sales representative in the Central States and the New England district, has been made assistant domestic sales manager. Vincent Roddy, formerly of the planning and research division, has been appointed assistant to the general manager, Eugene E. Clark. Harry Mayoh will continue as sales promotion manager, the position to which he was recently appointed.

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